

OSF – Introdução

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Conteúdo

1 Psychromemical Properties of solids

1.1 Single particles:

- Shape
- hardness
- compressive resistance
- electrical charge
- (intraparticle) porosity

1.2 Bulk solids:

- Particle size distribution
- (interparticle) porosity
- humidity
- agglomeration
- flowability
- ...

1.3 Solids suspensions (heterogenius mixture in a fluid, gás or liquid)

- Particle size distribution
- Concentration of solids
- viscosity of suspension
- flocculation
- settleability
- ...

Properties of single particles

1.4 Shape

(i) Regular shape:

particles which its geometry is well defined by mathematical equations

- Sphere
- Cylinder
- Cube...

Sphere:

$$\text{Volume: } \pi d^3/6 = 4 \pi r^3/3$$

$$\text{Surface Area: } \pi d^2 = 4 \pi r^2$$

$$\text{Projected area in a plane: } \pi d^2/4 = \pi r^2$$

Note: Spheres are special as its completely symmetrical whilst the others depend on the orientation

(ii) Complex regular shapes

- Maximize surface area per Volume
- Used in packed columns in chem and biochem engineering

(iii) Irregular shapes

- Cannot be identified by math equations
- Characteristic dimension d
 - Sphere Diameter with same volume
 $V_{\text{particle}} = V_{\text{sphere}}$
 - Sphere Diameter with same Surface area
 $S_{\text{particle}} = S_{\text{sphere}}$
 - Sphere Diameter with same Surface per volume
 $\frac{S_{\text{particle}}}{V_{\text{particle}}} = \frac{S_{\text{sphere}}}{V_{\text{sphere}}}$

Derivando propriedades:

Length $L = d$

Volume $V = \ddot{k} d^3$

Surface area $S = \dot{k} d^2$

Mass $m = \rho_S V = \rho_S \ddot{k} d^3$

• Surface factor: $\dot{k}_{\text{sphere}} = \pi$

• Volume factor: $\ddot{k}_{\text{sphere}} = \pi/6$

1.5 Particle Distribution Curves

Cumulative \iff Frequency

Diff ways to measure quantity

- n**: Number fraction
- s**: surface fraction
- x**: weight fraction
- l**: lenght fraction
- v**: volume fraction

Property	Whole	Fraction
Number	$: n_i, d_i$	n_i
Length (m)	$: l = n_i d_i$	$l_i = \frac{n_i d_i}{\sum n_j d_j}$
Surface (m ²):	$s = n_i \dot{k} d_i^2$	$s_i = \frac{n_i d_i^2}{\sum n_j d_j^2}$
Volume (m ³):	$v = n_i \ddot{k} d_i^3$	$v_i = \frac{n_i d_i^3}{\sum n_j d_j^3}$
Mass (kg)	$: x = n_i \rho \ddot{k} d_i^3$	$x_i = \frac{n_i d_i^3}{\sum n_j d_j^3}$

Mean diameter:

Can be based on different properties of solid like weight, number or volume.

$$\bar{d}_\alpha = \frac{\int d \, d\alpha}{\int d\alpha} = \frac{\sum d_i \, \alpha_i}{\sum \alpha_i} : \alpha \left\{ \begin{array}{l} x : \text{Weight} \\ n : \text{Number} \\ v : \text{Volume} \\ s : \text{Surface} \\ l : \text{Lenght} \end{array} \right.$$

Weight and Number

$$\left\{ \begin{array}{l} \text{Measured in number } n \\ \bar{d}_x = \bar{d}_v = \frac{\int d \, d(n \, \rho \, \ddot{k} \, d^3)}{\int d(n \, \rho \, \ddot{k} \, d^3)} = \frac{\int n \, d^3 \, dd}{\int n \, d^2 \, dd} = \\ = \frac{\sum d_i (n_i \, \rho \, \ddot{k} \, d_i^3)}{\sum (n_i \, \rho \, \ddot{k} \, d_i^3)} = \frac{\sum n_i \, d_i^4}{\sum n_i \, d_i^3} = \\ \text{Measured in Weight } x \\ = \frac{\sum x_i \, d_i}{\sum x_i} \end{array} \right.$$

Surface

$$\left\{ \begin{array}{l} \text{Measured in number } n \\ \bar{d}_S = \frac{\int d \, d(n \, \dot{k} \, d^2)}{\int d(n \, \dot{k} \, d^2)} = \frac{\int d^2 \, n_i \, dd}{\int d \, n_i \, dd} = \\ = \frac{\sum d_i (n_i \, \dot{k} \, d_i^2)}{\sum (n_i \, \dot{k} \, d_i^2)} = \frac{\sum n_i \, d_i^3}{\sum n_i \, d_i^2} = \\ \text{Measured in Weight } x \\ = \frac{\sum \left(\frac{x_i}{\rho \, \ddot{k} \, d_i^3} \right) d_i^3}{\sum \left(\frac{x_i}{\rho \, \ddot{k} \, d_i^3} \right) d_i^2} = \frac{\sum x_i}{\sum x_i / d_i} \end{array} \right.$$

Lenght

$$\left\{ \begin{array}{l} \text{Measured in number } n \\ \bar{d}_L = \frac{\int d \, d(n \, d)}{\int d(n \, d)} = \frac{\int d \, n \, dd}{\int n \, dd} = \\ = \frac{\sum d_i (n_i \, d_i)}{\sum (n_i \, d_i)} = \frac{\sum n_i \, d_i^2}{\sum n_i \, d_i} = \\ \text{Measured in Weight } x \\ = \frac{\sum \left(\frac{x_i}{\rho \, \ddot{k} \, d_i^3} \right) d_i^2}{\sum \left(\frac{x_i}{\rho \, \ddot{k} \, d_i^3} \right) d_i} = \frac{\sum x_i / d_i}{\sum x_i / d_i^2} \end{array} \right.$$

Volume

$$\left\{ \begin{array}{l} \bar{d}_V = \frac{\int d \, dn \, \ddot{k} \, d^3}{\int dn \, \ddot{k} \, d^3} = \frac{\int n \, d^3 \, dd}{\int n \, d^2 \, dd} = \\ = \frac{\sum d_i (n_i \, \ddot{k} \, d_i^3)}{\sum (n_i \, \ddot{k} \, d_i^3)} = \frac{\sum n_i \, d_i^4}{\sum n_i \, d_i^3} \\ \text{Assuming all particles have the same size} \\ \sum n_i \, \ddot{k} \, \bar{d}_V^3 = \ddot{k} \, \bar{d}_V^3 \sum n_i = \sum n_i \, \ddot{k} \, d_i^3 \implies \\ \implies \bar{d}_V = \sqrt{\frac{\sum n_i \, d_i^3}{\sum n_i}} \end{array} \right.$$