

Desired property of powder:

1. Porosity
2. Bulk density
3. Flow property

True density

- It is the density of material itself.
- It can be defined as true density as

$$\rho_p = \frac{\text{mass of the powder}}{\text{True volume of the powder}}$$

Granule density

Granule density is defined as $\rho_g =$

$$\rho_g = \frac{\text{granule weight}}{\text{granule volume}}$$

Bulk density

It is defined as $\rho_b = \frac{\text{mass of the powder}}{\text{bulk volume of the powder}}$

Introduction:

- For calculation of bulk density the apparatus used called bulk density apparatus
- It consists of a ~~meas~~ measuring cylinder in which the powder can be taken.
- The apparatus contains a plate in which the no of tapping is counted.
- The instrument is attached to a rubber cushion over the smooth tapping so that the cylinder won't break.
- A fixed quantity of powder is taken in one of the measuring cylinder and the volume is calculated called True Volume.
- Then the powder containing in measuring cylinder will be tided for 100 times
- This volume is again calculated and another 50 tappings will be held upto getting the constant volume.
- Then the bulk volume will be calculated then this bulk density is measured.

Porosity:

Pure volume = volume of the powder itself

Granule volume = volume of the powder
+
Volume of intraparticles space (pores)

Bulk volume = volume of the powder itself
+
volume of inter particles space
+
volume of intra particles space (voids)

if dry powder is non-porous then no interparticle pores or intraparticle spaces present
 → in that condition bulk volume is equal to true volume + volume of interparticle spaces (voids)

→ True void volume = bulk volume - True vol.

$$V = V_b - V_p$$

$$\begin{aligned} \text{True value of porosity} &= \frac{\text{void volume}}{\text{bulk volume}} \\ &= \frac{\text{bulk volume} - \text{True volume}}{\text{bulk volume}} \end{aligned}$$

$$= \frac{V_b - V_p}{V_b}$$

$$\% \text{ of porosity } (\epsilon) = \frac{V_b - V_p}{V_b} \times 100$$

$$= \left(1 - \frac{V_p}{V_b}\right) \times 100$$

→ True porosity is also be expressed in terms of density so the formula will be

$$\epsilon = \left(\frac{\rho_p - \rho_b}{\rho_p} \right) \times 100$$

Q. Calculate the % porosity of talc that has a true density of 2.70 g/cm³ when 100 gm of powder is placed in a 100 ml container. Calculate the %

Given, True Density of talc = 2.70 gm/cm^3

weight of talc = 1.00 gm

(V_b) bulk volume = 62 ml

$$S_b = \frac{100}{62}$$

$$= 1.613$$

$$\epsilon = 1 -$$

$$\text{True density} = \frac{100}{\text{True volume}}$$

$$\text{True volume} = \frac{100}{2.70} = 37.037$$

~~$$= \frac{V_b - V_p}{V_b} \times 100$$~~

~~$$= \left(\frac{62 - 37.037}{62} \right) \times 100$$~~

~~$$= \left(1 - \frac{37.037}{62} \right) \times 100$$~~

bulk density

$$S_b = \frac{100}{62} = 1.613$$

$$\% \epsilon = \left(1 - \frac{S_b}{S_p} \right) \times 100$$

$$= \left(1 - \frac{1.613}{2.70} \right) \times 100$$

$$= (1 - 0.597) \times 100$$

$$= 40.03\%$$

Answer

Particle Arrangement

The arrangement of particles in a powder influences volume accepted by it.

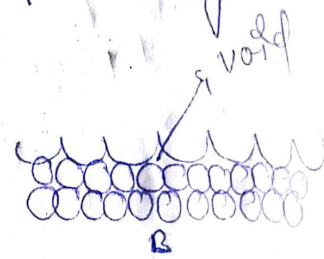
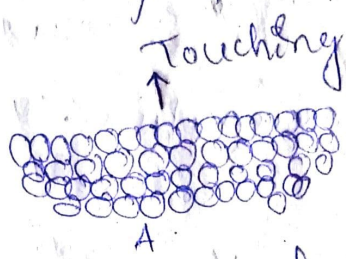
→ As a result bulk density, porosity are affected, it also affects the disintegration & dissolution of powder.

→ When the particles are considered as uniform in size as that of spheres then the following arrangements are possible.

⇒ **Closest**

- 1. **Rhombohedral packing**

⇒ must open, loosest or cubic packing



First two layers of closely packed spheres or particles

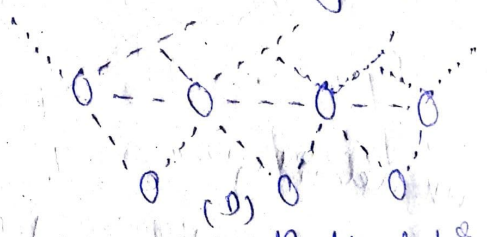
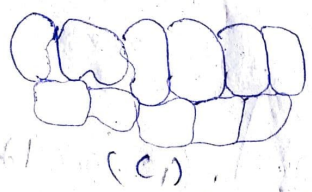
First two layers are shown

↓
particles are arranged in closest packing

particles are arranged in loosest packing

$(\epsilon) = 26\%$

porosity $(\epsilon) = 48\%$



Dotted line indicates particles contact single layer is shown

Small particles accommodate the voids betⁿ large particles, single larger voids being shown pharmaceutical powders particle are arranged very closely, porosity (ϵ) is less than 30%.

(ϵ) is greater than 50%.

- increase of closest packing the porosity is smaller i.e. about 46%.
- increase of loosest packing the porosity is more but present of more void spaces in betⁿ the particles. Hence the porosity is about 48%.
- ⇒ this air-ph. central powder in general thing consists of the 50-50% of porosity.
- ⇒ if the particle size distribution will be different then the smaller particles can be accommodated in betⁿ the voids of large particle hence the porosity is less than 30%.
- ⇒ when the porosity are aggregated, or distributed then the porosity is more than 50%.

Angle of repose

- Flow characteristic of powder can be measured by angle of repose.
- ⇒ The angle of repose is defined as the maximum angle possible betⁿ the surface of the pile of powder & the horizontal plane.
- ⇒ Angle of repose can be rewritten as, $\tan \theta = \frac{h}{r}$.

$$\theta = \tan^{-1} \frac{h}{r}$$

where, h = height of pile

r = radius of base of pile

θ = angle of repose

There are another formula for calculation of repose i.e. $\cos \theta = \frac{D}{L+D}$ on

$$\theta = \cos^{-1} \frac{D}{L+D}$$

center of base

L_1 & L_2 = opposite sides of the pile

Method:

- A glass funnel is held in place with a clamp on a ring support over a glass plate.
- Then the glass plate is placed on a microlab jack.
- Approximately 100 gm powder is transferred into the funnel after passing 10 mesh sieve.
- The orifice of the funnel will be blocked by the thumb.
- As the thumb is removed, the lab jack is adjusted and set a 6.4 mm gap between the bottom of funnel & top of powder pile.
- Then the powder is emptied into a tray from the funnel, and the process variables are calculated by the procedure.

Angle of repose

Flow property

25-30

Excellent

31-35

Good

36-40

Fair, and if not needed

41-45

passable, may hang up

46-55

poor, must agitate or vibrate

56-65

very poor

> 66

very very poor

* Carr's consolidation Index

Carr's compressibility Index

The formula is $\frac{\text{tap density} - \text{bulk density}}{\text{tap density}}$

Wagner's ratio

Formula is

$$\frac{\text{Fluff density} \times \text{volume}}{\text{Tapped volume}}$$