Rheology

Lab3 Industrial Pharmacy

Definition

Rheology is the flow properties of pharmacological particles.

Rheo= Flow

Disadvantages of using powders

The most popular dosage forms was powder but by time it's converted to tablets and capsules because of the following disadvantages of powder dosage form:

1. **Inaccuracy in weight.**
2. **Can not be used for drugs having hygroscopicity because it absorb moisture.**
3. **Can not be used for powders that have bad taste.**

Why we study rheology of powder!!

Powder or granules utilized in a particular form during some phase of manufacture.

i.e. (A- Modern tablet machine can produce 5-20 thousands tablets/min, B- Capsule machine can produce about 150 thousands capsules/min

To ensure this type of production **(the integrity of powder flow rate)**

We should ensure flowability of the powder.

Types of powder flowability:

- Freely flowable powder
- Non-freely (sticky) flowable powder

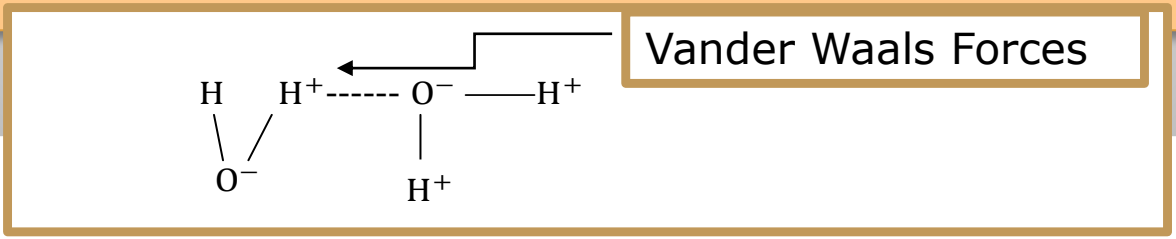
Factors reducing flow rate

1. **Intermolecular forces:**

Weak cohesive forces **on the surface of the particles** of different charges (Vander Waals forces).

E.g. When two molecules interact (brought close together) both repulsive and attractive forces (opposite charges on both molecules are close together)operate.

Molecules will attract to each other leading to bad flowability.



2. Frictional Forces (electrostatic forces):

Present on the surface of the particle and they manifest their effect due to friction between particles during movement.

Note: As the surface area increases

↓

friction increases

↓

formation of charges increases

↓

flowability decreases.

Note:

Charges developed depend on:

- A- Particle size.
- B- Materials involved.
- C- Type of motion produced in it (like harmonic, circular, random and rotary) .

3. Shape of particles:

Good flowability

Spherical particle with small surface area.

Bad flowability

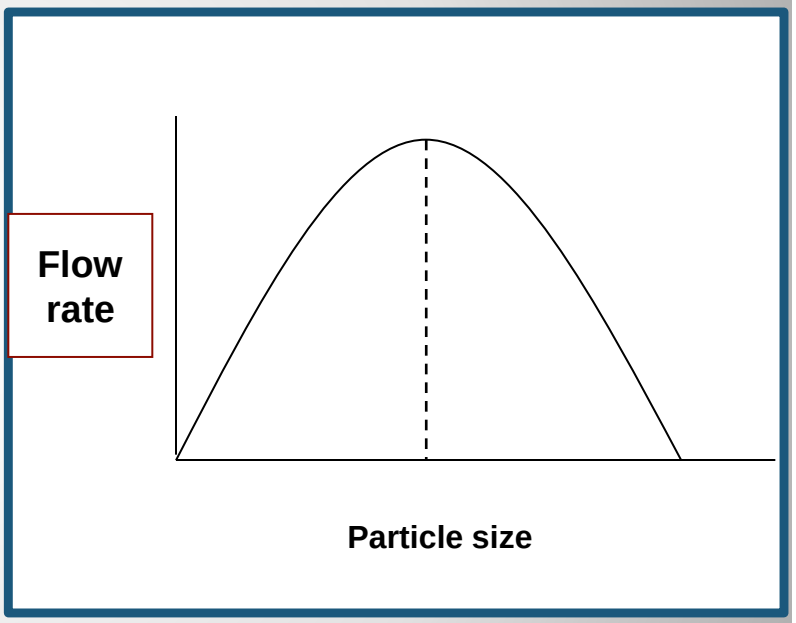
A-Irregular particles or particles with needle and crystalline shape.

B- Flat particles and particles with rough surface.

4. Size of the particles:

- Bad Flowability (**small particles** have *high surface area* and *high frictional forces*).

- **Note:** **if the size of the particle is too large it may not be able to enter the orifices of the instrument**.



5. Moisture:

- **Good Flow**: The flow by the absorbed layer of moisture on the particle surface

Reduce the chance of any complicating electrostatic effect by producing conduction path of charge dissipation.

- **Bad Flow**: Excessive moisture higher than that of 50 %

forming moisture bridges between particle which will cause sticky mixture.

Improving flowability by

1.Formulation additives (glidants):

A- Talc.

B- Magnesium oxide

C- Colloidal silicon Dioxide

(They generally act by disrupting the continuous film of adsorbed water surrounding the moist particles in addition to lodging in the surface irregularities forming a more rounded structure reducing the bulk density of tightly packed powder).

2. Force feeder (which push the powder down in the die).

3. Vibrating Hooper (provide regular vibration allowing the powder to flow continuously).

Note:

Bad flowable powder may cause the following :

1- Weight variation in the final product.

2- Non uniform particle packing.

3- Air entrapment within the powder which may cause tableting problems.

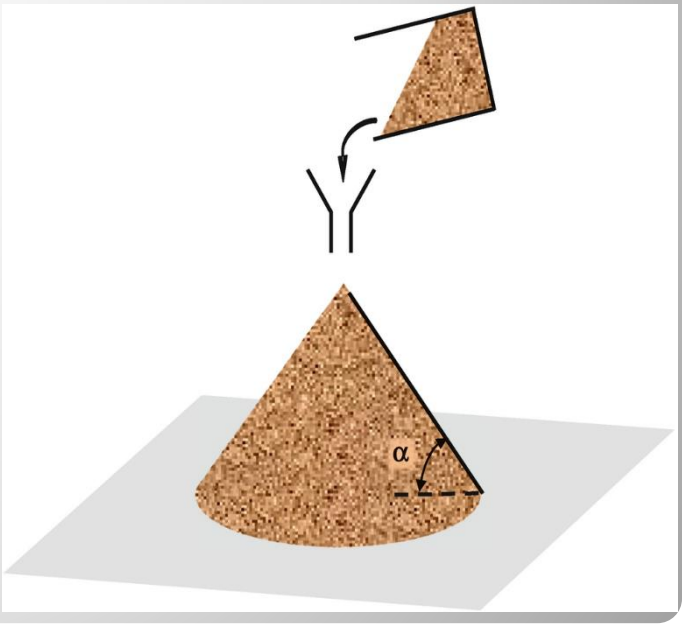
4- Excessive fine particles which cause lubricating problems.

Measurement of flowability

1. **Flow meter** (determine the flow rate and provide a means of quantifying uniformity of flow).

2. **Angle of repose (funnel and petri dish method)**

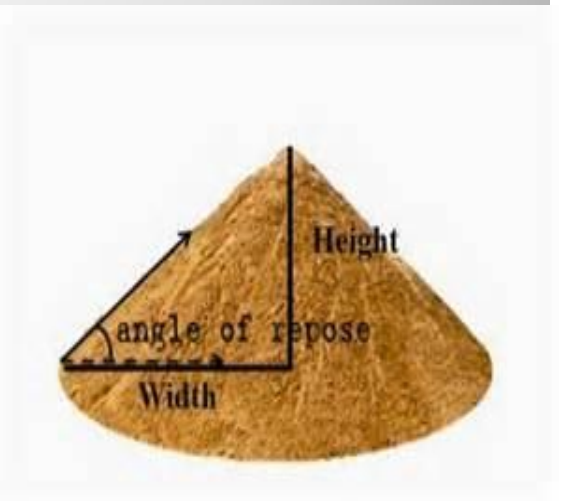
Simple method for estimating the flow properties of a powder, by allowing the powder to flow through a funnel and fall freely onto a surface, the **height and the diameter** of the resulting cone will be **measured** and the **angle of repose (which is the maximum angle between the free standing surface of the powder heap and the horizontal plane)**.



This angle can be calculated from the following equation:

$$\tan \theta = h / r$$

Where θ = angle of repose,
h = height of the powder cone,
and r = radius of the cone.



Notes:-

- Angle of repose range from 0°- 90° depending on type of powder, it is related to density, surface area, shape of particles, coefficient of friction of the material.

- The value of angle of repose increases if the powder is cohesive.

This table represent the scale of flow determined from Carr's scale of flowability:

Flow property	Angle of repose
Excellent	**25° -30°**
Good	**31°-35°**
Fair (aid not required)	**36°-40°**
Passable (may hang up)	**41°-45°**
Poor (must agitate , vibrate)	**46°-55°**
Very poor	**> 55°**

Angle of repose measurement

1- Fixed funnel free standing cone method

2- Fixed cone method

Fixed funnel free standing cone method

1-Keep the funnel on **constant height** (about 2 cm) on a horizontal plane.

2-The powder to be measures poured gradually through the funnel onto a paper **until the Pile apex reaches the tip of the funnel.**

3-Mark the base of the formed pile and remove the powder.

4-Measure the diameter of the formed circle (2 readings) and take the average (d1+d2/2)

5- Find the radius (d/2)

6- Calculate θ (tan θ= h/r)

Fixed Cone method

1-The **diameter or radius (r)** of the pile base is kept **constant** by using a petridish on a horizontal plane.

2-The funnel should be kept in the center of the petridish .

3- The height of the funnel is changeable keeping a (2-4 cm) space between the Pile apex and the tip of the funnel during powder pouring.

4-The end point is reached when the base of the petiridish is fully covered with the powder.

5- Find the height of the formed pile.

6- Calculate θ ($\tan \theta = h/r$)

Please use the following links for the experimental work

- https://www.youtube.com/watch?v=4J61a6-zBDA
- https://www.youtube.com/watch?v=mpf1wxG0R7c&t=319s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