Aim :

To evaluate the flow properties of the given powder by the angle of repose.

Reference :

Dr. Ashok A. Hajare, "A Practical Book of Physical Pharmaceutics - II, 1st edition, Nirali Publication, Jan 2019, Page no. - 22 - 25.

Requirement :-

Chemical :- Glucose and Starch.

Glassware and apparatus :- Funnel, Burette stand / Tripod stand, Butter paper, Spatulla, Graph sheet, Weighing balance.

Theory :-

The angle of repose is a frequently reported value in bulk solids characterization. The angle of repose measurement relies on the assumption that the concerning bulk solid heap resembles the geometric shape of a perfect cone, which roughly holds true for free-flowing materials. The angle of repose for different materials is measured to describe the flow of each material.

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Angle of repose	Properties
0 - 25	Excellent
25 - 30	Good
30 - 40	Passable
Above 40	Very poor

Mixture	Granules	Glucose	Starch
1	20 gm	10 gm	10 gm
2	20 gm	5 gm	15 gm
3	20 gm	15 gm	5 gm

Smaller angle indicates a good flow property compared to bigger angle. Several factors that influence the angle of repose is also metho determined which are the particle size, particle shape, cohesiveness and the method by which the angle is measured. Smaller particles have a bigger angle of repose due to the cohesiveness. This cohesivity causes a poor flow. Mixture of particles with various sizes also gives a bigger angle of repose owing to the friction. Besides the angle of the repose is also gravity-dependent.

Many instruments have been commercially available to measure the angle of repose to check the flow property of the material. The commonly used methods for determination of angle of repose include thing tilting box method, fixed funnel method, fixed cone method and revolving cylinder method. Manual measurement of this angle is done by fixed funnel method where free hand circle is drawn around the boundary of pile of the powder material. The height of the pile is kept fixed as the distance between the flat platform and the tip of the funnel from which the powder is allowed to fall suspended onto the platform. Formation of pile of the powdered material on a flat platform is critical step in this determination. Usually, height of the pile is kept fixed for convenience. The diameter and ultimately the radius of the pile is then measured.

Observation and Calculation

Mixture	Trial	Name of Powder	Height of heap	Radius	Angle of repose	Flow Properties
1	1	Glucose –10gm	2.5	7.6	17.74	Excellent
	2	+	2.2	7.3	16.17	"
	3	Starch –10gm	2	8.3	13.49	"
2	1	Glucose – 5gm	1.5	8.6	9.64	"
	2	+	.8	7.6	5.7	"
	3	Starch– 15gm	2.2	7.8	15.64	"
3	1	Glucose –15gm	1.5	8.1	10.20	"
	2	+	2.1	6.3	18.77	"
	3	Starch – 5 gm	1.9	7.5	14.00	"

S.No.	Mixture	Angle of repose Average	Flow properties Average
1	Glucose + starch	15.8	Excellent
2	Glucose + Starch	10.32	"
3	Glucose + Starch	14.32	"

Numerous methods used for measuring angle of repose produces slightly different results. Results are sensitive to the exact methodology of the experimenter. Angle of repose is the maximum angle possible between the surface of a pile of powder and the horizontal plane. If more material is added to the pile, it slides down the sides until the mutual friction of the particles produces a surface at an angle (θ) is in equilibrium with the gravitational force. The tangent of the angle of repose is equal to the coefficient of friction.

$$\tan \theta = \mu$$

Thus,
$$\theta = \tan^{-1} \mu \qquad\qquad -①$$

$$\tan \theta = \frac{h}{r} \qquad\qquad -②$$

Finally using equation (3), the angle is calculated.

$$\theta = \tan^{-1}\left(\frac{h}{r}\right) \qquad\qquad -③$$

Where, 'h' is the height of the pile and 'r' is the radius of the base made by the pile of the powder. The rougher and more irregular the surface of these particles, the higher will be the angle of repose. It ~~found~~ is unaffected by static charges on the particles and is independent of particle shape.

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For a good flowing powder, the angle of repose should be between 30° - 40°. As the angle of repose decreases the flow will be good.

The additions of glidant (or lubricant) like talc or magnesium stearate can after alter the angle of repose. Generally, the flow of the materials is improved with the addition of a glidant at low concentration and only work at a certain range of concentration.

Procedure :-

Determination of angle of repose by two sided open and cylinder method

(i) Place the cylinder or funnel on the graph sheet. Now take a small quantity of powder in cylinder and funnel. Left cylinder slowly a heap is formed.

(ii) Measure the height and radius of the heap and calculate the angle of repose.

Result :-

The flow properties of various sample was determined successfully.