School of Pharmacy

B.Pharmacy (3rd Semester)

Lab Manual
Of
Pharmaceutical Engineering (BP308P)

List of Practicals:

Experiment no.	**Aim**
1.	To determine the radiation constant of unpainted glass.
2.	To determine the values of vaporization efficiency (η_v) and thermal efficiency (η_t) for steam distillation of aniline
3.	To find out the overall heat transfer coefficient
4.	To determine the construction of drying curve for calcium carbonate
5.	To determine the moisture content and loss on drying
6.	To Determination of humidity of air – i) From wet and dry bulb temperatures –use of Dew point method
7.	Description of Construction Working and application of Pharmaceutical machinery Such as Rotary Tablet Machine, Fluidized Bed Coated, Fluid Energy Mill, Dehumidifier
8.	To determine the average particle size and find out their distribution pattern for the given granules by sieve analysis method
9.	To verify the laws of size reduction using ball mill and determining Kicks, Rittinger's, Bond's coefficients, power requirement and critical speed of Ball Mill.
10.	Demonstrating Colloid Mill, Planetary Mixer, Fluidized Bed Dryer, Freeze Dryer.
11.	To study the effect of various factors on the rate of filtration
12.	To study the effect of various factors on the rate of evaporation
13.	To study the effect of time on the rate of crystallization
14.	To calculate the uniformity Index for given sample by using Double Cone Blender

Experiment -1

Aim: To determine the radiation constant of unpainted glass.

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering", Nirali Prakashan Publication, Page no.1-5.

Requirements:

a. **Apparatus:** Round bottom flask, thermometer, water bath, measuring cylinder, and beaker. Hot plate or burner

Stain with clamp, Stop clock, Tripod stand

b. Chemicals: Distilled Water.

Principle:

Flow of heat takes place from the high temperature region towards the low temperature region. This is based upon the following three mechanisms.

A) CONDUCTION

It is considered as one of the efficient modes of heat transfer by heat transfer occurs through transfer of the momentum of each atoms or molecules without mixing conduction is limited to solids and fluid.

B) CONVECTION:

In this made of heat transfer, the warmer parts mix with the colour parts of the same substance heating of water by using coil type water heater is one of the examples of convections here, the energy is transferred as heat to a flowing fluid by a hot surface convection is limited to the flow of heat in fluids (i.e, liquids and gases).

C) RADIATION:

Mechanism of heat transfer through a space by means of electromagnetic waves is called radiation. A good examples of radiation is black body radiation which occurs by absorbing all energy incidents upon it, at the same time the quantitatively transferred into heat the radiant thermal energy expressed by **"STEFFAN BALOZMANN"** equation as given below.

$$q = bAT^4$$

Where,

q = energy radiated per second
(w) A= Area of radiating

surface (m^2)
T= absolute temperature of the radiating surface
(k) b= constant $w/m^2 \times k^4$

Radiation constant is calculated by using following equation,

$$\mathbf{M_1 S_1 - M_2 S_2 \, dq/dt = \alpha A [(T_1/100)^4 - (T_2 - 100)^4] + b A (T_1 - T_2)}$$

PROCEDURE:

❖ A round bottom flask is cleaned and dried.

❖ The weight of the flask is determined(M_2/kg)

❖ The diameter(d) of neck of flask is determined

❖ Boil hot water is prepared and measured volume of hot water is transferred to the flask (M_1). The volume of water is external surface of the round bottom flask is thoroughly dried the flask with hot water is placed on the tripod stand.

❖ Thermometer (110^0) is dipped to centre of the flask and tied at the top to and iron stand.

❖ Slowly the temperature of the hot body decreases.

❖ The decrease in temperature is noted every minute.

❖ The data are recorded in table.

❖ A graph is plotted by taking time (minutes) or X-axis and temperature on Y-axis normally is a curve is obtained.

❖ Depending on the temperature at which radiation constant is determined, a tangent is draw at that temperature the slope is calculated (dq/dt).

❖ Radiation constant (α) is determined at the temperature.

Calculations:

Diameter of round bottom flask (d) =
Radius of round bottom flask (r) =
Diameter of neck of round bottom flask (d) =
Radius of neck of round bottom flask(r) =
Surface area of round bottom flask = $4\Pi r^2 - \Pi r^2$
Empty weight of round bottom flask (M2) =
Volume of heat water with flask (M_1) =
Room temperature (t_2) =
Derived room temperature (t_1) =
Specific heat of water (r_1) =
Specific heat of glass (r_2) =

$$\mathbf{M_1 S_1 - M_2 S_2 \frac{dq}{dt} = \alpha A [(T_1/100)^4-(T_2-100)^4]+b A (T_1-T_2)}$$

Result: The radiation constant of unpainted glass α =

Experiment-2

Aim: To determine the values of vaporization efficiency (ηv) and thermal efficiency (ηt) for steam distillation of aniline

Reference: Dr. Sakarkar DM, Mr. Sudke S G., "Laboratory Manual of Pharmaceutical Engineering", Nirali Publication, page no. 26.1-27, 33.1-34.

Apparatus: Distillation flask, steam generator, water cooled condenser, thermometer, separating funnel, specific gravity bottle, measuring jar.

Theory: Steam distillation is the term applied to a batch of continuous distillation process with open steam. The liquid is distilled by feeding open steam directly into the distillation still, so that the steam carries with it the vapors of volatile liquid component and is then condensed to separate the liquid from water. Steam distillation is possible only when, 1.The substance does not react with steam at the given conditions of temperature and pressure. 2. The substance is insoluble in water. Steam distillation method is used for the separation of high-boiling substances from non-volatile impurities or for the removal of very high-boiling volatile impurities from still higher-boiling substances. The process has special value where it is desired to separate substances at temperature lower than their normal boiling points because of heat sensitivity or other reasons. The condensed organic liquid and water do not miscible in each other. Therefore partial pressure of each component is equal to vapor by each liquid. If P is total pressure, PA and Pw are vapor pressure of organic liquid and water respectively. Then P = PA + PW. For ambient distillation, P = 1 atm = 101.3 kpa. Therefore PA v/s T and (101.3 – Pw) v/s T plots intersects and this point corresponds to distillation temperature.

PROCEDURE:

1. Take 100 ml aniline in the distillation flask and set up the apparatus.
2. Pass the steam at a pressure of 0.25 kg/cm²
3. Note down the distillation temperature.
4. Pass the steam till about 60-70 % of the liquid distills.
5. Stop the steam and allow the residue and distillate to get cooled.
6. Using the separating funnel, separate aniline and water in residue and distillate.
7. Measure the volume of aniline and water in residue and in distillate and find out specific gravities.
8. Draw a graph of ln Pw vs ln Ps and calculate the slope. Then calculate λs.
9. Draw Hans-brandt chart [plot of (760 – Ps) vs. temperature and Pw vs. temperature) to find out the theoretical distillation temperature and compare it with the actual value.

OBSERVATIONS AND CALULATIONS:

Volume of aniline taken = 100 ml
Distillation temperature Td = °C Room temperature Tr = °C
Steam temperature Ts = ° C (from steam tables)
Steam pressure, P = 0.25 kg/cm² - 0.3 kg/ cm²
Cp, s = ... (from perry's H.B)
Cp, w = ... (from Perry's H.B)

λw = ...(from Perry's H.B)
To get λs, obtain Vapor pressure data for aniline and water (from Perry's H.B)
Then
λs= [Mw / Ms] [d(ln Pw) / d (ln Ps)] x [λw]
[d(ln Pw) / d(ln Ps)] is given by slope of ln Pw Vs.
ln Ps plot Wt. of empty sp. gr. bottle = W1 = ...g
Wt. of empty sp. gr. bottle + water = W2 = ...g Description Volume (ml)

For calculation of
ηv and ηt

$$\eta v = \frac{[Ws / Ww] \text{ actual}}{[Ws / Ww] \text{ ideal}} \times 100 = ...\%$$

$$\eta t = [St / Sa] \times 100 = ...\%$$

Results:

For steam distillation of aniline
Vaporization efficiency, ηv = ...
%Thermal efficiency, ηt = ...%

Experiment-3

Aim: To determine the overall heat transfer coefficient by heat exchanger

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering" Nirali Publication Page no15-17.

Requirements:

- **Apparatus:** Steam distillation apparatus
- **Chemicals :** Distilled water,

Theory: Heat transfer by convection is involved between two liquids, when these are separated by glass wall. The differences in the modes of feeding largely determine the efficiency of a heat process.

When the hot fluid and the cold fluid enter the apparatus from the same end, the flow is parallel to each other.

This arrangement is known as parallel flow.

When the hot fluid and the cold fluid enter the apparatus from the other end, the flow is parallel to each other.

This arrangement is known as counter current or counter flow method.

Procedure:

1. The length and diameter of the plain water condenser is determined and reported in the observation. Based on these values surface area of the condenser is estimated.
2. Using the plain water condenser, the distillation apparatus is assembled.
3. The inlet of water condenser is connected to the tap. The outlet of the condenser is placed in the beaker.
4. The temperature of the tap water inlet is noted.
5. The steam generator is heated so that steam is produced. As the steam is generated, the steam thermometer shows constant temperature. The temperature is noted.
6. As the process continues, a steady state situation is obtained. At this stage heat transfer measurement made.
7. The condensate begins to collect into a empty beaker. At the same time, the water is collected from the outlet into an empty vessel.
8. After lapse of time collecting of condensate is stopped by removing the bottle from the rubber tubing.
9. Exactly the same time, collecting of tap water from outlet is stopped by removing the bottle from the rubber tubing.
10. The condensate is swirled and the temperature is noted. The quantity of condensate is measured and recorded.
11. The tap water collected into the bottle is also swirled and temperature is noted. The

quantity of tap water is measured or recorded.

Observations and calculations:

Diameter of condenser, d = -------- cm = ----- m

Radius of the condenser, r = --------cm = ----- m

Length of condenser, l = -------- cm = ----- m

Area of condenser A = $2\pi rl$

Result:

Experiment -4

Aim: To determine the construction of drying curve for calcium carbonate.

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering" Nirali Publication Page no 52-55

Requirements:

- **Apparatus:** Petri dish , hot air oven, Weighing balance, spactula
- **Chemicals :** Calcium Carbonate, Distilled water,

Principle:

To behavior of drying of solid is explained by drying curve. The time required for drying a batch of weight of martial in a dry air can be estimated with the help of drying curve. Drying is a mass transfer process consists of the removal of water or other solvent by evaporations from a solid, semisolid or liquid. This process is obtained used as final production steps before, packing products.

Procedure:

- Take a clean Petridish without Lid and consider it's weight as W_1gm
- Note the area of petridish
- Take 10gm calcium carbonate in a clean petridish and consider its weight as W_2 gm
- Prepare slurry by adding water consider it's weight as W_3 gm
- Heat petridish in hot air oven at temperature of 70°C
- Note down the weight of the sample after every 15 minutes.
- Continue drying until there is no change in weight of the sample is obtained
- Determine percentage moisture content and drying rate by using following formula
- Percentage moisture = W3-W2/W3-W1 × 100
- Drying content =W3-W2/area of petridish ×100

Calculation:

Weight of empty petridish (w_1) gm =

Weight of empty petridish + sample (w_2) gm =

Weight of empty petridish + sample + water (w3) gm = Weight of empty petridish + sample + water + (w4) gm = (After drying at different time interval)

MC1 (moisture content at 0 time) = W_3-W_1 / W_2-W_1

MC2 (moisture content at 15 minutes time) = W_4-W_1 /

W_2-W_1

Rate of drying = $W_3 - W_2$ / area(A) petridish × time

Result:

The construction of drying curves of calcium carbonate was determined

The percentage moisture content is =

Experiment -5

Aim: To determine the moisture content and loss on drying

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering" Nirali Publication Page no 127-129.

Requirements:

Apparatus: Petridish, Measuring cylinder, Pipette, Tray dryer, Spatula, Weighing balance
Chemicals: Calcium Carbonate, Distilled Water.

Procedure:

- Take clean dry petri dish and weight it (x)
- Weigh 10g of calcium carbonate powder and transfer to petri dish and weight it
- Add sufficient amount of water with the help of pipette to the powder until slurry form.
- Again weigh the petridish and note down weight (y)
- Place the petridish in tray dryer and weigh it at every 5 min
- Allow it to dry until it's constant weight the down the constant dry weight (z)
- Calculate the percentage loss on drying and percentage moisture content for the given sample.

Calculation:

Weight of empty petridish (x) =

Weight of empty petridish + sample + water (y) =

Weight of empty petridish + sample + water (After drying at every 5 minutes) =
Loss of drying = weight of moisture sample / total weight of wet sample
Percentage of moisture content: weight of moisture sample / total weight of Dry sample

Result:
The moisture content and loss on drying was determined
The percentage of moisture content is =
The loss on drying is =

EXPERIMENT -6

AIM: To Determination of humidity of air – i) From wet and dry bulb temperatures –use of Dew point method.

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering" Nirali Publication Page no 147-149.

Requirement: Round bottom neck flask, 100ml, thermometer, 1100 C, glass tripod stand.

Theory: Humidity of the environment is an important factor that is routinely monitored and maintained in the production areas of various unit dosage forms such as tablets, capsules.
Dew point is defined as the temperature to which a mixture of air water vapour must be cooled to become saturated.

Procedure:

- A round bottom long neck flask (100ml) is thoroughly cleaned and dried the external surface.
- Water is filled into the flack upto 2/3 rd volume.
- The above flask is kept on a glass tripod stand.
- The thermometer is dipped in the water.
- Crushed ice slowly added to the water and stirred thoroughly with the help of a glass rod.
- As the temperature of water is lowered must begins to form on the outer bottom surface of the flask. At this point temperature is noted. This is a dew point.

Observation and calculation:

Trials	**Dew point , ^{0}C**		**Humidity**
	Mist appearance	**Average value**	

Result:

EXPERIMENT -7

Aim: Description of Construction Working and application of Pharmaceutical machinery Such as Rotary Tablet Machine, Fluidized Bed Coated, Fluid Energy Mill, Dehumidifier.

Reference: Dr. Sakarkar DM, Mr. Sudke SG., "Laboratory Manual of Pharmaceutical Engineering", Nirali Publication, Page no. 10.1-11.

Requirement: Rotary tablet machine, fluidized coater

Procedure:

1) ROTARY TABLET MACHINE:

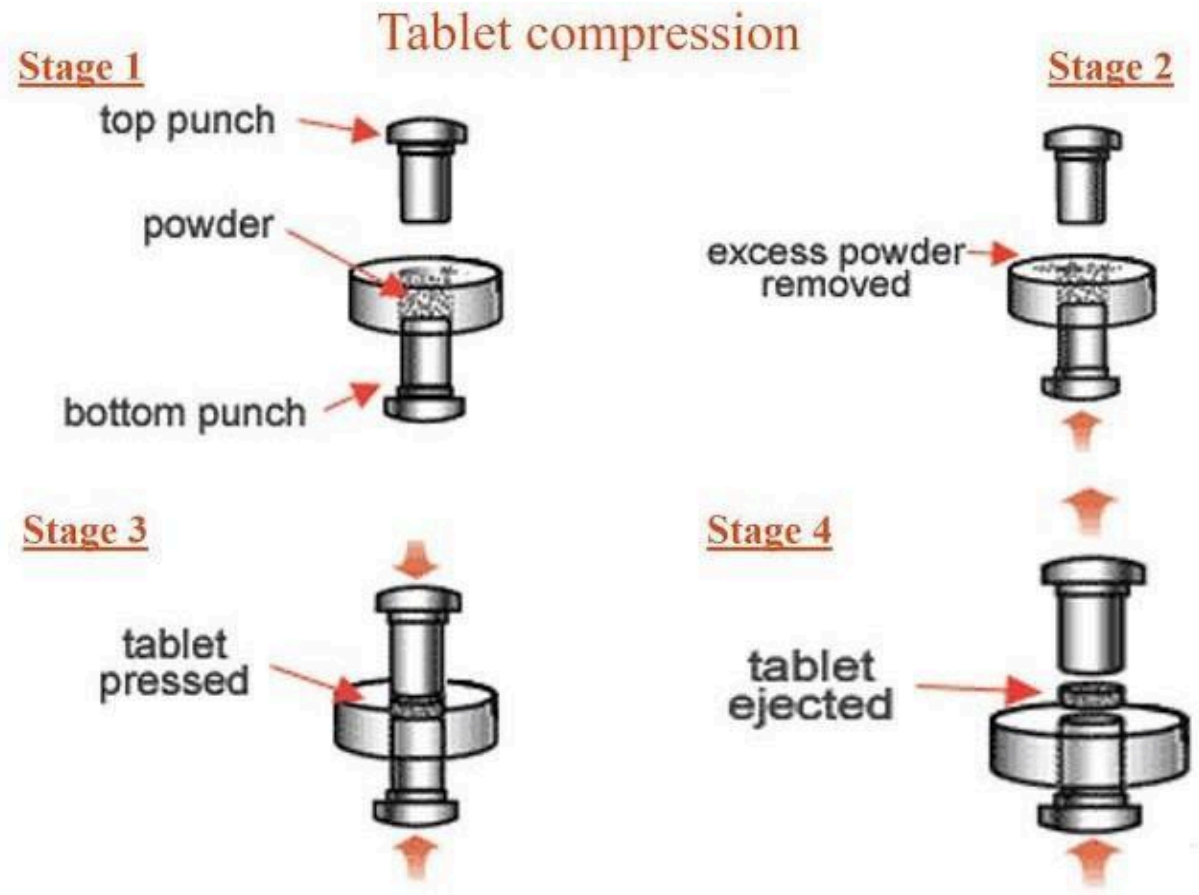
It is also called multi station tablet press. It is called rotary machine rotary machine because the head of the machine that holds the upper punches, dies and lower punches in place rotates.

Steps involved in manufacturing of tablet:

- The material to fed through hopper
- The fill cam pulls the lower punches down to a fixed distance and the dies are filled with material
- The quantity of the material filled is larger than the actual amount required, remove excess amount with the help of spatula
- After that, upper punch is lowered and inserted into the dies
- The material is compressed and the tablet are formed
- After the compression, pulls the upper punches into their top position and simultaneously lift the lower punches until the tablets are ejected from the dies
- Then the tablet is passed through discharge chute

Applications:

- It is operated continuously
- Used for large scale production
- A single rotary press produce 1150 tablets in a minute while double rotary press can produce 10,000 tablets in a minute



2) FLUIDIZED BED COATER:

Three types of air suspension coater are available, namely top spray coater, wurster or bottom spray coater, and tangential spray coater. In top spray coater, there is a counter current (opposite position) it movement of powder particles or pellets and liquid spray. In wurster or bottom spray coater, there is a concurrent (same direction) movement of powder particles or pellets and liquid spray. In tangential spray coater, the powder particles or pellets move in a helical fashion due to spinning rotor disk on the bottom of the equipment.

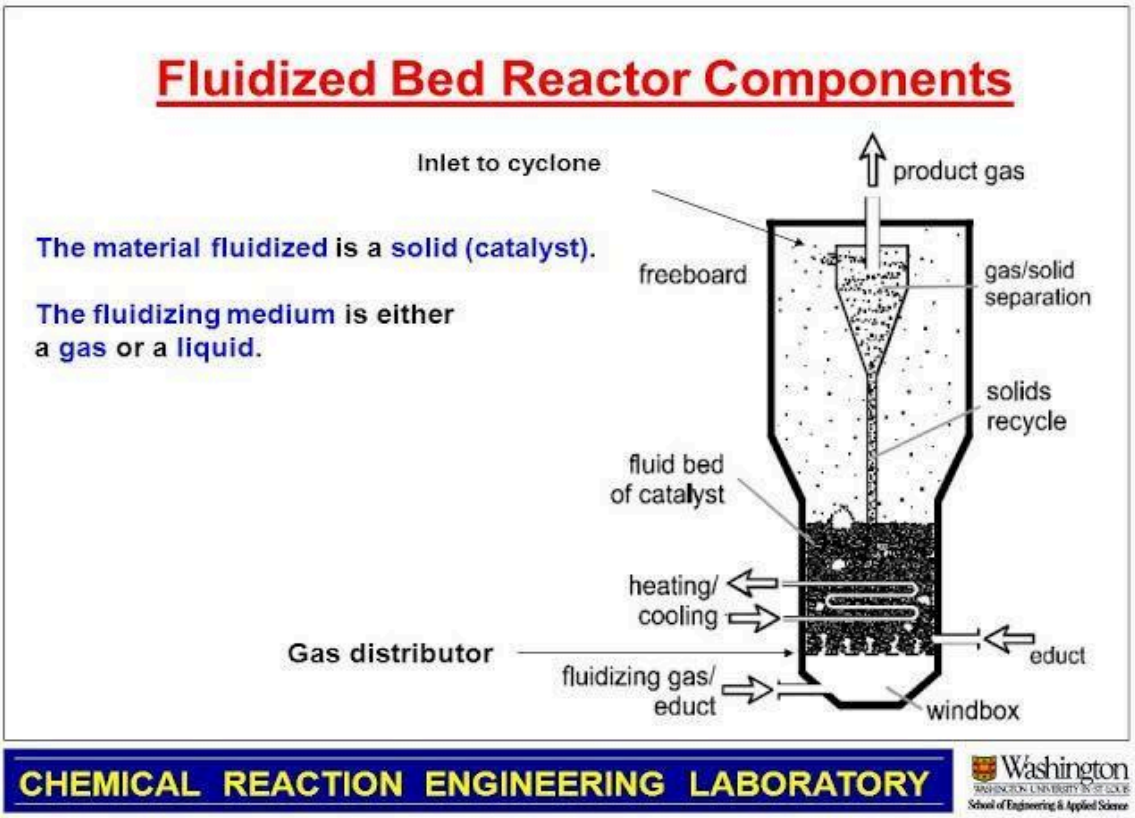
Steps involved in wurster or bottom spray coater:

- ✔ The drying inlet air is passed upwards through the bottom perforated plate into the fluid bed chamber
- ✔ This air passes to wurster column, in which a spray gun perpendicular to bottom plate and parallel to the wurster column
- ✔ This air passes out from the exhaust filters situated at the top of the equipment
- ✔ The material to be coated is located is loaded in the fluid bed chamber and fluidized

- ✔ The inlet air cause fluidization of the material as well as its drying during the coating operation
- ✔ The pellets are pass through the liquid spray of coating solution from the spray gun positioned parallel to the column
- ✔ After coating the coated particle falls by gravity at the bottom of wurster column and recycled to coating zone.

Application:

- ❖ It is used to coat pharmaceutical dosage form with polymeric material to mark objectionable taste or odour and also to protect an unstable ingredient and to improve appearance
- ❖ Fluidized bed coaters are used for coating of powders, granules, tablets, pellets etc by column of air
- ❖ Fluidized bed coating equipment is popular for coating multiparticulate systems such as beads and non parallel seeds.



3) FLUID ENERGY MILL:

- ❖ A fluid usually air is injected at very high pressure through nozzles at the bottom of the loop, as a result turbulence produce
- ❖ Solids are introduced into the steam through hopper

❖ Due to this turbulence occur and impacts and attrition occur between the particles

❖ A classifier is fitted at the exist so that only finer size particles are collected as products

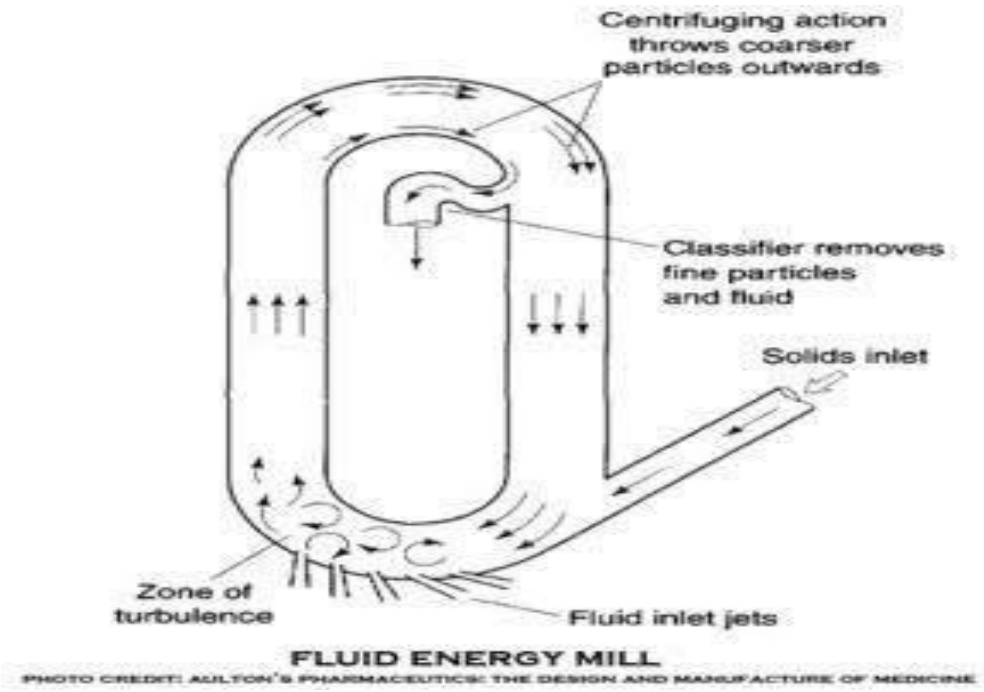
❖ The larger size particles are again sent to the stream of air for further size reduction

Application:

✔ The particle size of the product is smaller when compared to other method of size reduction

✔ No chance of contamination of the product

✔ This material is suitable where fine powders are required like micro ionization or griseofulvin



FLUID ENERGY MILL

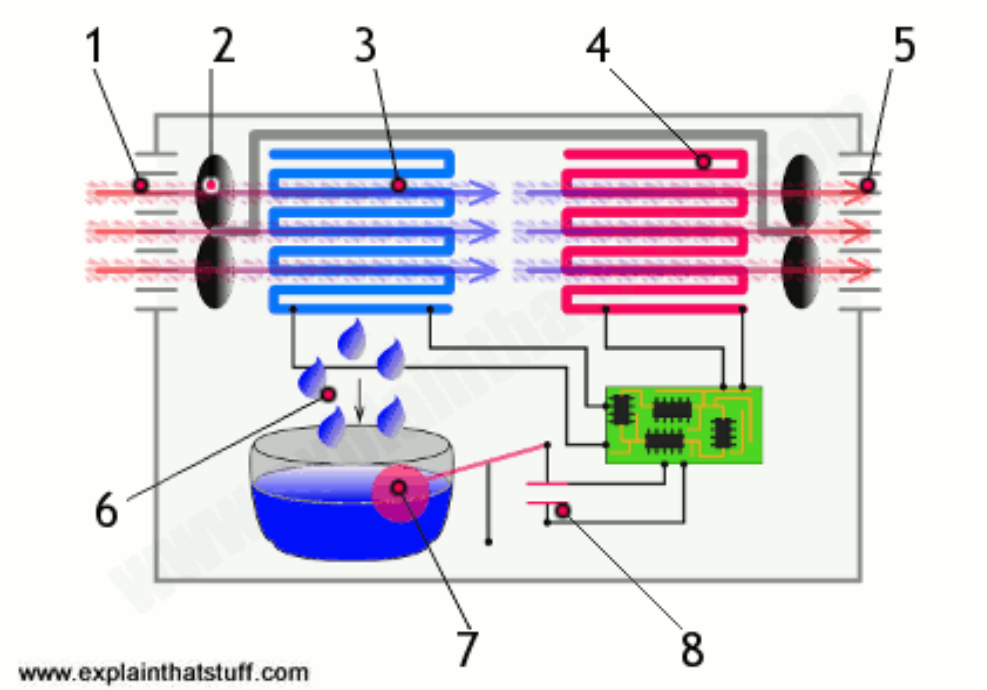
PHOTO CREDIT: AULTON'S PHARMACEUTICS: THE DESIGN AND MANUFACTURE OF MEDICINE

4) DE-HUMIDIFIER:

- Warm moist air is sucked in through one side of the machine
- An electric fan is used to draws the air inward
- The warm air passes through cold pipes through which a coolant circulators, due to cooling of air, the moisture it contains turns back into liquid water
- Then the air passes over a heating element and warms back up to its original temperature
- Warm, dry air blows back into the room through another side of machine
- The moisture that was in the air drips down into a collecting tray at the bottom of the machine
- As the collecting tray fills up, a plastic float in the machine rises upward
- When the tray is fill, the float trips an electric switch that turns off the fan and switches on an indicator light which indicates that the machine needs emptying

Applications:

- A dehumidifier is used to reduce the levels of humidity in the air
- Large dehumidifier are used in commercial buildings such as indoor ice rinks to control the humidity level



Experiment -8

Aim: To determine the average particle size and find out their distribution pattern for the given granules by sieve analysis method.

Reference: Subramanyam CVS, "Laboratory Manual of Pharmaceutical Engineering", Nirali Publication, Page no. 27-35

Requirements:

a. **Apparatus:** Seive Shaker,
b. **Chemicals:** Zinc oxide, Calcium carbonate, Magnesium Stearate

Principle:

Sieve method gives sieve diameter, sieve diameter is defined as the diameter of the sphere that possess through the sieve aperture as the asymmetric particle sieve method directly give weight distribution. Particles having size range from 50 and 1500µm are estimated by sieving method. In this method, the size is expressed as d_{sieve}. The sieving method finds application in dosage and development of tablets and capsules. Normally 15 percent of fine powder (passed through mesh 100) should be present in granulated material to get a proper flow of material and achieve good compaction in tableting. Therefore, percent of coarse and fine can be quickly estimated. Sieves for pharmaceutical testing are constructed from wire cloth with square meshes, woven from wire of brass, bronze, stainless steel or any other suitable material.

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Sieve Number	Aperture Size Micrometer	Sieve Number	Aperture Size Micrometer
10	1700	44	325
12	1400	60	250
16	1000	85	35
22	710	100	36
25	600	120	34
30	500	150	36
36	425	170	35

Advantages of sieving method

1. It is in expensive, sample and rapid with reproducible results.
2. Sieving method is useful when particles are having size range between 50 and 1500µm.

Disadvantage of sieving method

1. Lower limit of the particle size is 50µm.
2. If the powder is not dry, apertures become clogged with particles leading to improper sieving.
3. During shaking, attrition occurs causing size reduction of particles. This leads to errors in estimation.

Factors influencing the sieving method

Factors influencing sieving are weight of sample, duration of shaking and type of motion. The types of motion influencing sieving are vibratory motion, (most efficient), side tap motion, bottom pat motion, rotary motion with tap and rotary motion. The type of motion standardized. Care should be taken in order to get reproducible results.

Procedure:

1. Standard sieves set is selected (sieve no: 10, 22, 36, 44, 65, 80, 100,120) arrange them in such manner that the coarsest remains at the top and finest at the bottom.
2. Weigh approximately 50g of sample, place the sample on the coarsest sieve no.10.
3. Fix the above sieves set on hand sieve shaker and shaken for 20 minutes.
4. Collect the Sample retained on each sieve into a paper, weigh all the ample.
5. Report the weights retained on each sieve in the table against corresponding sieve number.

Sieve No	Aperture Size As Per I.P (µm)	Arithmetic Mean Size of opening (d) (µm)	Weight of Granules Retained on Sieve over Size (gm)	% Wt of Granules Retained (Under Size) N	Cumulative % Granules retained (Under Size)	Weight Size (n×d)	% Under Size	% Over Size (100-% Under Size)

Result:

The average diameter of the given granules was found to be = µm

Experiment-9

Aim: To verify the laws of size reduction using ball mill and determining Kicks, Rittinger's, Bond's coefficients, power requirement and critical speed of Ball Mill.

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering", Nirali Publication, Page no. 36-38

Requirement: Ball mill, sieve set , balance, energy meter.

Theory : Size reduction is a process of reducing large solid masses into small unit masses, coarse particles or fine particles.

Principle: Ball mills also known as tumbling mills or pebble mills. The ball mill works on the principle impact between the readily moving balls and material.

Procedure:

1. The initial dial reading of energy meter is noted as N_1.
2. The clean metal chamber is taken with sufficient number of balls.
3. The ball mill is operated without loaded for 30 min.
4. The reading in energy meter is noted down, N_2.(The difference between N_{2-} $N_{1\ is}$ N_3.
5. Hundred grams of sample is weighed and subjected to sieve analysis is transferred to ball mill.
6. Hundred grams of feed is weighed and subjected to sieve analysis. The average particle size of sample is calculated
7. The ball mill is operated for 30min.
8. The reading is noted down as $N_{4.(}$ The difference I.e. $N_5 = N_4 - N_2$ gives the energy required for running the ball mill and size reduction of material)
9. The difference i.e. $N_6 = N_5 - N_3$ gives the energy actually consumed for the size reduction of material.
10. The product is unloaded on to a tray and subjected for sieve analysis.
11. The average particle size of the product after size reduction is determined.

Result:

Experiment-10

Aim: Demonstrating Colloid Mill, Planetary Mixer, Fluidized Bed Dryer, Freeze Dryer.

Reference: Dr. Sakarkar DM, Mr. Sudke S G., "Laboratory Manual of Pharmaceutical Engineering", Nirali Publication, page no. 1.1-1.6, 10.1-10.2, 11.1-11.4.

Requirement: Fluidized bed dryer, colloid mill, planetary mixer, freeze dryer

Procedure:

1) COLLOID MILL:

- The colloid mill used to reduce the size of the suspended droplets
- The material is feed in through the inlet hopper and placed into the mill
- It is then move through the narrow gap between the rotor and stator to reduce the particle size
- Then final product is removed through the outlet

Colloidal mill

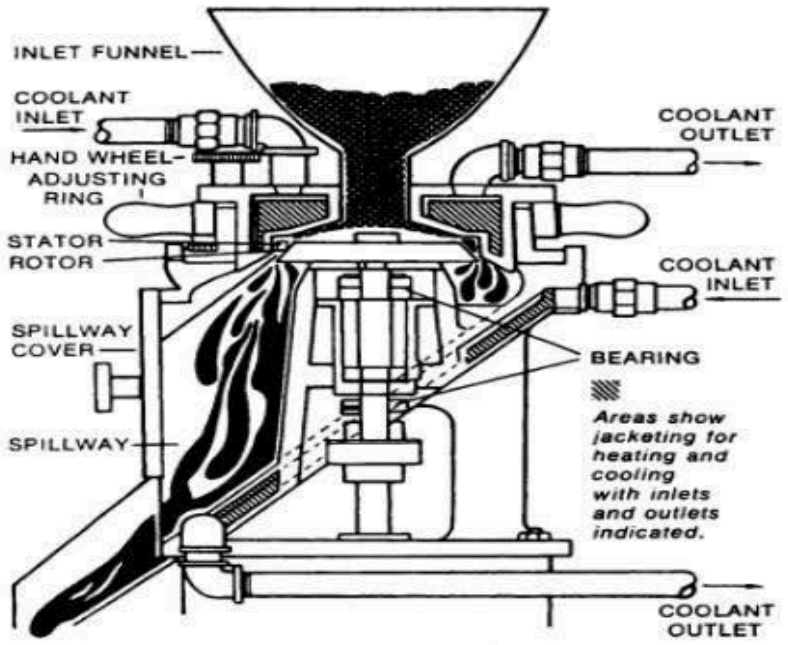
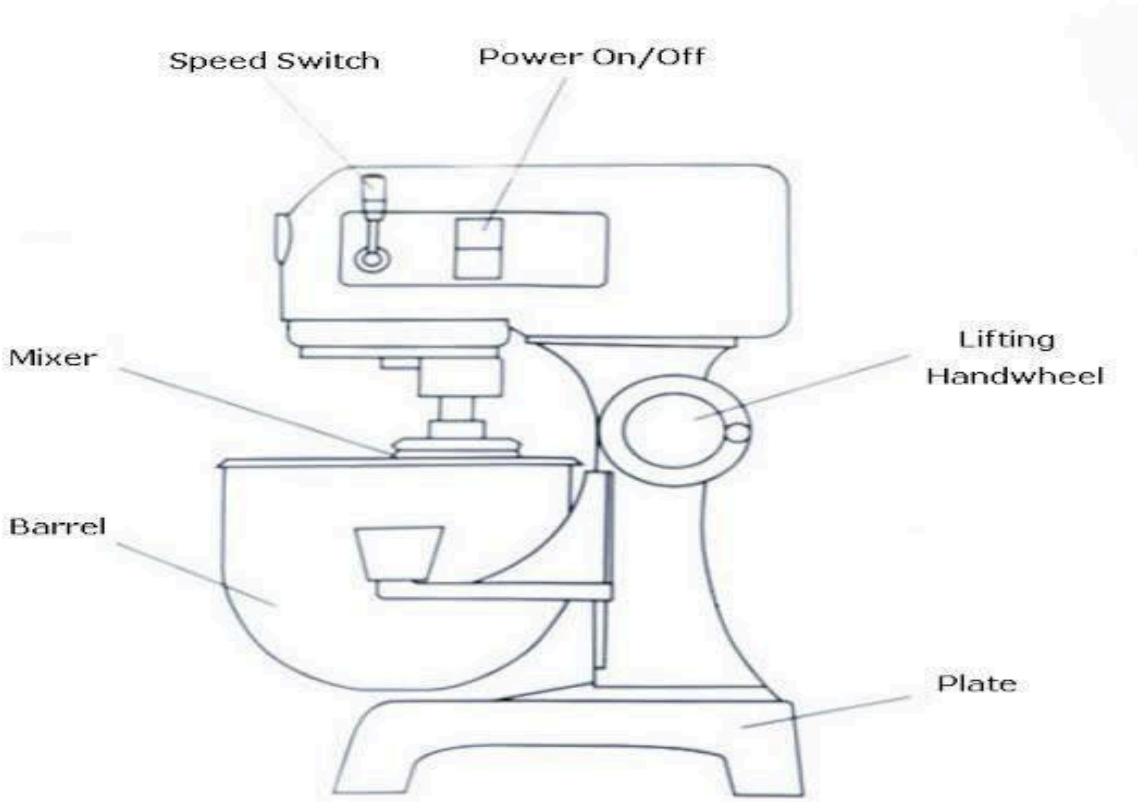


Fig. 32 Cross-section of colloid mill. (From Ref. 29.)

2) PLANETARY MIXER:

- The material to be mixed is loaded into mixing bowl or shell
- The blades rotate on their own axis when they orbit the mixing bowl on a common axis. Therefore there is no dead spot in the mixing and high shear is applied for mixing
- After mixing, the material is discharged through a bottom value or by manual scooping of the material from the bowl



Planetary Mixer

3) FLUIDIZED BED DRYER:

- The wet granules to be dried are placed in a detachable bowl, the bowl is inserted in the dryer
- Fresh air can pass through a pre filter, which is then heated when passing through a heat exchanger
- Hot air flows through the bottom of the bowl at the same times, the fan starts to rotate the air speed increases gradually
- After a specific time a pressure point is reached in which the friction drag on the particles is equal to the force of gravity. The granules rise in the container. This condition is said to be fluidized state
- The gas surrounds each granule to dry them completely the air comes out of the dryer passing through the filters in the bag
- The entrained particles remain adhered to the interior of the surface of the bags. Periodically, the bags are shaken to remove entrained particles
- The materials are left in the dryer to reach room temperature
- The bowl is removed, the final product is free flowing

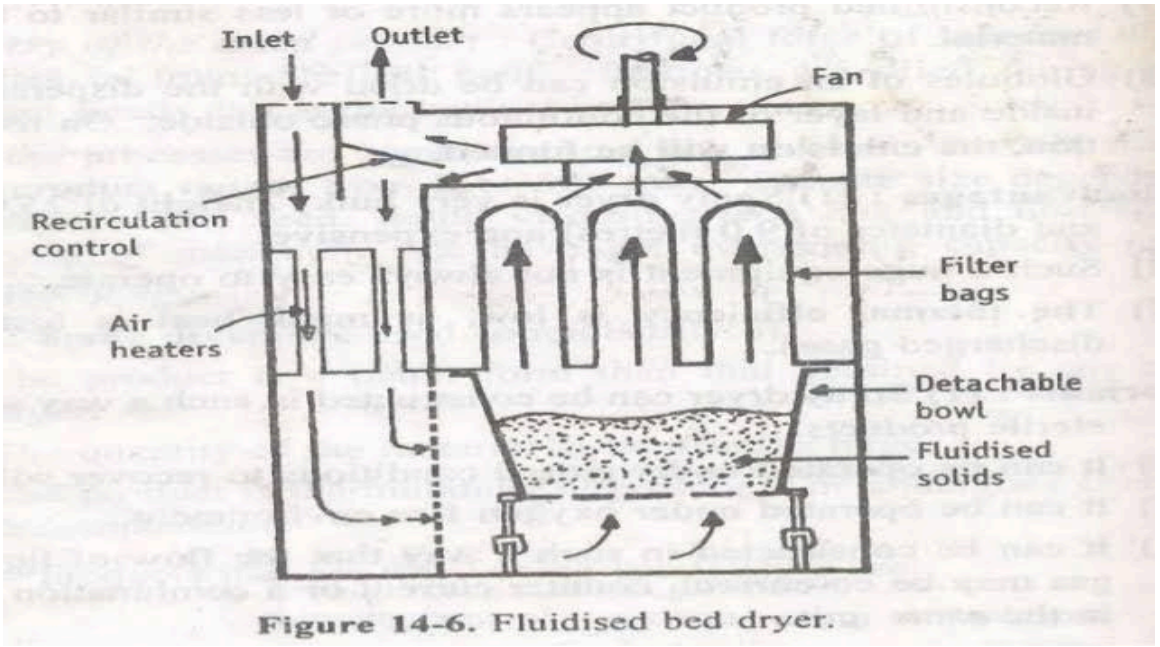
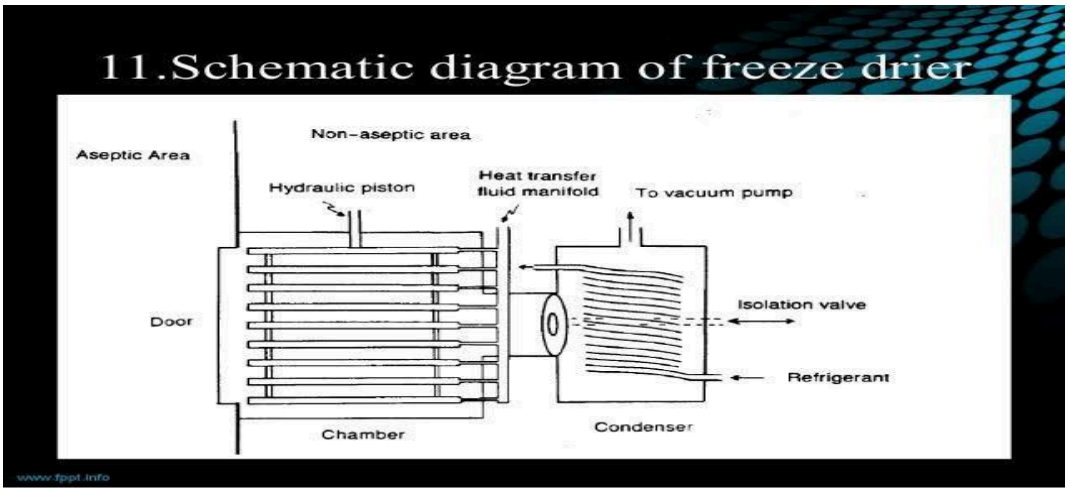


Figure 14-6. Fluidised bed dryer.



4) FREEZE DRYER:

- The material is pre-treated before freezing pre-treatment methods include freezing concentration, solution phase concentration and formulation to preserve the appearance of the product. Formulation to stabilize reactive products. Formulation to increase the surface area and decreasing high vapour pressure solvent
- The product should be frozen at a temperature low enough to solidify completely. The products are frozen in two ways, most of the products that are lyophilized consist mainly of water. It is very important in lyophilisation to pre-freeze the product below the eutectic temperature before beginning the lyophilisation process
- After the pre-freezing the product conditions must be established in which the ice can be removed from the frozen product through sublimation resulting in a dry, structurally intact product
- After primary freeze drying is completely and all the ice has sublimed, bound moisture is still present in the product. The product appears dry, but the residual moisture content may be as high as 7-8% continued drying is necessary at warmer temperature to reduce the residual moisture content to optimum value. This process is called “isothermal desorption” secondary drying is usually carried out for approximately 1/3 or 1/2 the time required for primary drying
- After vacuum is replaced by inert gas, bottle and vials are closed

Experiment -11

Aim: To study the effect of various factors on the rate of filtration

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering", Nirali Publication, Page no. 76-79

Requirement:

Apparatus: Beaker, Filter paper, measuring cylinder

Chemical: Calcium carbonate, Glycerin**.**

Principle:

Filtration is a process of where by solid particles present in a suspension are separated from the liquid or gas employing a porous medium. Which retains the solid but allows the fluid to pass through the volume of the filtrate obtained through the filter paper per unit time is called "**rate of filtration"** can be given by mathematical equation.

dv/dt = K.A . ΔP/μL – darcy's law

Where,

A = area of filter

ΔP = pressure drop across the filter medium and cake

μ = viscosity of filtrate L = thickness of cake
V = volume of the
filtrate T = time
taken for filtration
K = constant for the filter medium and filter cake or resistance.

Procedure:

a) Effect of thickness of cake:

Prepare two solutions of calcium carbonate using water as the solvent the concentration of the solutions are 5% and 10% respectively. Filter them and note the time taken for filtration to calculate the rate of filtration and compare them.

b) Effect of viscosity:

Effect of viscosity causing two solutions one with water and other with mixture of glycerin and water (20:80) ratio respectively. Prepare two different solutions of 5% calcium carbonate ($CaCo_3$) using above prepared water and glycerine mixture. Filter them and note the time for filtration to calculate the rate of filtration and compare them.

c) Effect of area:

This can be determined by using funnel of large (big) and small area for the same concentration of the solutions (5% $CaCo_3$) time taken for filtrations are noted. Calculate the rate of filtration and compare them.

d) Effect of pressure:

Prepare two solutions of calcium carbonate (5% $CaCo_3$) using water as a solvent filter one of the solutions through Buchner funnel. Which is connected to a suction pump and the other one is filtered through without suction pump and note the time taken for filtrate. Calculate the rate of filtration and compare them.

Calculation:

Effect of thickness of cake:

Sample: 50 ml of 5% $CaCo_3$

50 ml of 10% $CaCo_3$

Sample	**Time Taken For Filtration**	**Volume of Filtrate**	**Rate of Filtration**
5% $CaCO_3$	5 minutes (300 seconds)		
10% $CaCO_3$	7 minutes (420 seconds)		

Effect of viscosity:

Sample: 50 ml of 5% CaCO3

50 ml of 10% CaCO3 (Glycerine and water mixture 20:80)

Sample	**Time Taken For Filtration**	**Volume of Filtrate**	**Rate of Filtration**
5% $CaCO_3$			
5% $CaCO_3$ with glycerin and water mixture			

Effect of area of funnel:

Sample: 50 ml of 5% $CaCO_3$

Sample	**Time Taken For Filtration**	**Volume of Filtrate**	**Rate of Filtration**
5% $CaCO_3$ filter in small funnel			
10% $CaCO_3$ filter in big funnel			

Effect of pressure:

Sample: 50 ml of 5% $CaCO_3$ (glycerine water mixture 20:80)

Sample	Time Taken For Filtration	Volume of Filtrate	Rate of Filtration
5% $CaCO_3$ filter with pressure			
10% $CaCO_3$ filter without pressure			

Result:

Rate of filtration in thickness

5% $CaCO_3$ =

10% $CaCO_3$ =

Rate of filtration in viscosity

5% $CaCO_3$ =

5% $CaCO_3$ with glycerine Water mixture =

Rate of filtration in area

5% $CaCO_3$ in small funnel =

5% $CaCO_3$ in big funnel =

Rate of filtration in pressure

5% $CaCO_3$ with pressure =

5% $CaCO_3$ without pressure =

Experiment -12

Aim: To study the effect of various factors on the rate of evaporation.

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering", Nirali Publication, Page no. 116-120.

Requirement:

Apparatus: Three petri dishes of diameter 2.50 cm, 5 cm, 7.5 cm with cover, 10 ml of pipette and stop watch
Chemicals: Glycerine, distilled water, beaker, measuring cylinder

Principle:

Evaporation is the process by which liquid water goes directly to the vapour phase due to an increase in temperature. The main objective of evaporation is to get a concentrated product by vaporizing volatile liquid. Evaporation is conducted by non-volatile solute and volatile solvent to produce thick liquor. Rate of evaporation is controlled by rate of heat transfer.

Objectives of evaporation:

Evaporation is done by following,

- To get a concentrated product
- To remove water from aqueous solution
- To evaporate sea water for developing drinking water
- To get solid from water which is used in boiler for chemical process

Factors influencing evaporation:

2. **Temperature**

The evaporation rate directly related to the temperature. As the temperature increases the rate of evaporation also increases because the temperature is rising the water molecules begin to move faster.

3. **Surface area**

The rate of evaporation is directly proportional to the surface area of the vessel exposed to evaporation.

4. **Agitation**

Agitation is necessary for evaporation.

5. **Vapour pressure**

Liquids with low boiling point evaporate quickly due to high vapour pressure.

6. **Types of product required**

The selection of the method and apparatus to be used for evaporation depends upon type of product required for example open pan produce liquid or dry concentrate while film evaporator yield liquid concentrates.

7. **Density**

As the density increases, the rate of evaporation decreases.

8. **Time of evaporation**

Exposure to a relatively high temperature for a short time may be loss destructive of the active ingredients than a lower temperature with exposure for a longer period.

9. **Economic factors**

When selecting the method and apparatus the economic factors are important. Evaporators are designed to give maximum heat transfer to liquid.

10. **Moisture content**

Some drug constituents decompose more rapidly in the presence of moisture especially as raised temperature.

Effect of surface area on the rate of evaporation:

Procedure:

- Clean and dry all petri plates and mark them as A, B, and C.
- Pipette out of 10 ml diethyl ether in each of the petri dishes A, B, and C and cover them immediately.
- All the petridish heated in water at constant temperature for 10 minutes
- Note the remaining volume after 10 minutes
- From the rate of evaporation is calculated

Effect of viscosity on the rate of evaporation:

Procedure:

- Different concentration of glycerine and water are prepared in different beakers.

- Note the weight of beaker containing glycerine- water mixture.
- All the beakers are heated in water at constant temperature for 10 minutes.
- Again note the weight of the beakers after heating.
- Difference between the weights is measured. The difference indicated the amount of water evaporated during 10 minutes.
- From the rate of evaporation is calculated

Effect of concentration on the rate of evaporation:

Procedure:

- Clean all the glassware's
- Prepare different concentration (2%, 4%, 6%, 8%) solution of sodium chloride in 50 ml water in different beakers
- Weigh of the beaker containing sodium chloride solution
- All the beakers are heated in water at constant temperature for 10 minutes
- Again weigh the beakers after heating
- The difference between weights is measured. The difference indicated the amount of water evaporated during 10 minutes
- From this rate of evaporation is calculated.

Effect of surface area:

Petridish Marked	Diameter of Petridish	Volume Taken	Remaining Volume	The Volume of Liquid Evaporated	Rate of Evaporation (ml/sec)
A	2.5	10 ml			
B	5	10 ml			
C	7.5	10 ml			

Result:

Rate of evaporation in surface area

A =
B =
C =

Effect of viscosity:

Glycerin (ml)	Water (ml)	Concentration % V/V	Initial Weight of Solution (g)	Final Weight (g)	Weight of Water Evaporated	Rate of Evaporation g/sec
2	5	2%				
4	10	4%				
6	15	6%				
8	20	8%				
10	25	10%				

Rate of evaporation in viscosity

2 ml =

4 ml =

6 ml =

8 ml =

10 ml =

Experiment- 13

Aim: To study the effect of time on the rate of crystallization.

Reference: 1. Subramanyam CVS, "Laboratory Manual of Pharmaceutical Engineering", Nirali Publication, Page no. 122-126.

2. Dr. Sakarkar DM, Mr. Sudke S G., "Laboratory Manual of Pharmaceutical Engineering", Nirali Publication, page no. 13.1-13.4, 14.1-14.2.

Requirements: Beakers, Slide, Cover slip, Microscope

Theory:

Principle: Crystallization or crystallization is the (natural or artificial) process by which a solid forms, where the atoms or molecules are highly organized into a structure known as a crystal. Some of the ways by which crystals form are precipitating from a solution, freezing, or more rarely deposition directly from a gas. Attributes of the resulting crystal depend largely on factors such as temperature, air pressure, and in the case of liquid crystals, time of fluid evaporation. Crystallization occurs in two major steps. The first is nucleation, the appearance of a crystalline phase from either a super cooled liquid or a supersaturated solvent. The second step is known as crystal growth, which is the increase in the size of particles and leads to a crystal state. An important feature of this step is that loose particles form layers at the crystal's surface lodge themselves into open inconsistencies such as pores, cracks, etc

Procedure:

- Refined bleached and deodorized palm oil are placed in a beaker which was initially heated in a thermally controlled water bath for 30 minutes at 70ºC to totally melt the oil.
- The temperature was then reduced to 30ºC within one hour followed by reducing to crystallization temperature of 14 or 22ºC within 30 minutes.
- Once the oil reached the desired temperature (14 or 22ºC), it was allowed to crystallize until 90 minutes where the analyses were made at 5,15,30,60 and 90 minutes to obtain the morphology of the crystals.
- The beaker content was constantly stirred at 90 rpm throughout the process using a stirring motor attached with two blades paddle propeller
- Samples of slurries were withdrawn at 5,15,30,60 and 90 minutes of crystallization and placed onto a slide which was then covered with a cover slip.
- Photograph of the crystals were taken at the magnification of 200x.
- The lengths of four longest dimensions of each crystal were recorded and an average of at least six crystals was measured during each observation.

Observation table:

Time (min)	Crystal Size (µm)
5	
15	
30	
60	
90	

Result:

Rate of crystallization of palm oil at the end of 90 minutes is = µm.

Experiment- 14

Aim: To calculate the uniformity Index for given sample by using Double Cone Blender

Reference: Subramanyam CVS, "Practical book of pharmaceutical engineering", Nirali Publication, Page no. 116-120

Requirements

Apparatus: Double Cone Blender

Material required: Two different or distinguishable substances (As yellow and brown mustard seed with same size).

Theory:

Mixing of solids: The mixing of solids, whether free-flowing or cohesive, resembles to same extent the mixing of low- viscosity liquid. Both processes intermingle two or more separate components to form a more or less uniform product. Some of the equipment normally used for blending liquids may, on occasion, be used of mix solids.

Measure of mixer performance: Quantitative measures of mixing, based on statistical procedures, are sometimes used to evaluate mixer performance. Their procedure is based on the analyses of spot samples taken from the mix at various times. A mixture in which one component is randomly distributed through another is said to be completely mixed.

Consider a mixture of components A and B from which N spot samples, each containing n particles, are taken and analysed. The standard deviation, S is estimated from the analytical results by the equation:

Where, $\mathbf{x}_i$ = Number of fraction of A in each sample

$\bar{\mathbf{x}}$ = average value of measured number fractions.

N = number of spot sample taken.

Even if the mixture is completely mixed, the value of xi in the various spot samples will not be the same; there is always same chance that a sample drawn from a random mixture will contain a larger (or smaller) proportion of one kind of particles than the population from which it was taken.

Procedure:

- Clean the container of Double cone blender.
- Pour Component A and Component B uniformly making layer one over another in the container of Double cone blender from the feeding port. Use chemical admixtures such as air entraining agent in the mix to avoid segregation, if necessary.
- Fix the RPM of the Double cone blender.
- Start the mixer and take spot samples at fix interval of time.

Calculation and observation:

Mixing Index is calculated by the formula:

= Minimum deviated Standard deviation value of mixer / Standard Deviation of mix of mixer

Result: