IMPORTANT QUESTIONS

of

PHARMACEUTICAL ENGINEERING

UNIT - Ist

1. Describe in details about Reynolds number (Reynolds experiment, flow pattern, applications, significance).
2. State and derive Bennoulli's theorem.
3. Write the principle and working of Manometer.
4. Write principle, construction and working of venturimeter.
5. Write a note on various laws governing size reduction.
6. Describe in details about fluid energy mill - (10)
7. Describe in details about ball mill - (10)

OR

Write a desciptive note on mills based on the principle of impact and attrition.

8. Describe in details about sieve shaker for size separation.
9. Write a short note on official standards of powders or seive sizes.
10. Write short note on elutriation tank.

UNIT - IInd

1. What is fourier's law? Write in details.
2. Describe in details about heat exchanger. - (10)
3. Write short note on mechanism of heat transfer.
4. Write down the principle, construction and working of Climbing film evaporator.
5. Write in details about Multiple effect evaporator and economy of multiple effect evaporation.
6. Write short note on :-
   i) factor influencing evaporation
   ii) Differences b/w evaporation & other heat process

⑦ Write short note on:-
- Horizontal tube evaporator
- forced circulation evaporator.

⑧ Describe in details about :- (10) Any one or two.
i) Steam distillation
ii) Molecular distillation
iii) fractional distillation.
iv) Distillation under reduced pressure

UNIT-III (14)

① Write a note on Mechanism and theories of drying.

② Write a short note on Rate of drying curve

③ Describe in details about :-
i) fluidised bed dryer
ii) freeze dryer
iii) Tray dryer.
iv) Spray dryer.

④ Describe in details about factor affecting mixing process.

⑤ Explain in details about :-
i) Twin shell (V cone) & Double cone blender
ii) Sigma blade mixer
iii) Planetary mixer
iv) Silverson emulsifier

UNIT-IV (14)

① Write a note on theories of filtration.

② Write a note on factor affecting rate of filtration.

③ Write down the principle, construction, working uses about filter leaf.

④ Write in details about :-
i) Plate and frame filter
ii) Rotary Drum filter
iii) Cartridge filter

⑤ Describe principle construction and working of perforated basket centrifuge

⑥ Describe principle construction and working of supercentrifuge

UNIT-Vth

① Write a details note on Corrosion — (10)
- Theories of corrosion
- Types of corrosion

② Describe the various factor affecting selection of material for construction.

③ Write a short note on :—
i) Stainless steel
ii) Glass
iii) Rubber

2 Marks Questions

① Define the following :— (10X2)
- fluids
- Size Reductions
- Size Separation
- Evaporation
- Distillation
- Drying
- Mixing
- filtration
- Centrifugation
- Corrosion

② Write short note on :— (7X2)
- Manometer
- Comminution
- Conduction
- Darcy law
- Equilibrium moisture content [EMC]
- Centrifugal effect
- Physical factors while selecting a material for plant construction.

(3) Define the following :- (7x2)
- Claification
- Uses of ball mill
- filter aid with examples
- Attrition
- Nominal size of aperture in seive
- flash distillation
- free moisture content

(4) Differentiate b/w fluid statics and fluid dynamics.
(5) Define attrition and impact.
(6) Define moderately fine powder according to IP
(7) What is difference b/w sedimentation and Elutriation.
(8) How evaporation differ from drying & distillation.
(9) Write the principle of steam distillation
(10) Difference b/w dry and wet corrosion.
(11) Difference b/w mixing and blending
(12) What do you understand by dead spot in solid mixing
(13) Express the mechanism of impingment and Entanglement.
(14) What is meant by under-driven and over driven assembly
(15) Define poiseiulle's equation.

IMPORTANT QUESTIONS OF PHARMACEUTICAL ENGINEERING

SOLUTIONS/ANSWERS

2 Marks Questions

① Define the following :-

— fluids :- The substance which have ability to flow.

eg :- Liquid & Gas (Both have movement and also deformation in shape).

— Size Reduction :- It is the process of in which we convert a drug (bulk particles) into small particles through any impact.

eg :- Tablet into powder

Mechanism used :- Impact, attrition, cutting etc.

— Size Separation :- It is the after process of size reduction, in which we separate out the mixture of various size portion into two or more portion by seive or any other process.

— Evaporation :- It is a process in which liquid is converting into gas (vapours) by absorbing heat.

eg :- Water into vapours (vaporization).

— Distillation :- It is used to purify a liquid by separating the components of a liquid mixture (separation of a liquid mixture).

- It occured due to difference in boiling point.

eg :- Separation of water from (alcohol + water).

— Drying :- It is the process of removal of small amount of liquid (moisture) by application of heat to obtain dry solid or solid products.

eg :- Drying of clothes etc.

- **Mixing** :- Mixing is defined as a process in which two or more components are mix together and convert into one form (mixture).

eg: Emulsion, Suspension etc....

— **filtration**:- It is a process of separation of solids particles from a fluid through any porous medium (which retain solids particles and pass liquid).

eg:- Hepa filter (remove solid particles from air).

— **Centrifugation** :- It is the process in which separation of particles take place by using centrifugal force.

eg:- separation of RBC, WBC and plasma in blood.

— **Corrosion** :- It is defined as the process of decomposition or destruction of metallic materials in the presence of environment through any electrochemical reaction.

eg:- Iron rust etc....

(2) Write short note on:-

— **Manometer** :- It is a device which is used to measure the pressure difference of fluids.

-formula ⇒ $\Delta P = \rho g h$ where, ρ = density, h = height, ΔP = Pressure

— **Comminution** :- It is the process of physical reduction of a substance to fine particle size, which makes the substance or drug easier to dissolve and compound.

* processes for comminution are cutting, grating, grinding, pulverizing and trituration.

— **Conduction** :- The transfer of heat or electric current from one substance to another by direct contact.

-the transfer of thermal energy by collisions between particles in matter.

— **Darcy law** :- It states the principle which govern the movement of fluid in the given substance,

-According to Darcy, ~~the flow between two~~ (2)

the factor influencing the rate of filtration has been incorporated.

$$V = \frac{KA\Delta P}{\eta L}$$

where,
V = Rate of flow
A = Surface area
ΔP = Pressure difference, η = viscocity
L = thickness of filtercake

- Equilibrium Moisture Content [EMC] :- When the moisture content of the solid is in equilibrium with the given partial pressure of vapour in the gas phase is called the EMC.
- process involved (Desorption & ~~Absorption~~).

- Centrifugal Effect :- Centrifugal forces is defined as "the apparent force that is felt by an object moving in a curved path that acts outwardly away from the centre of rotation.
  - The equipment used for separation is known as centrifuge.

- Physical factors while selecting a material for plant construction :-

-factors are
- strength, mass, wear properties, thermal conductivit
-Ease of fabrication, cleaning, sterilization.

(3) Define the following :-

- Clarification :- In filtration process, when suspending solid particles are 1% or less than 1% in any fluid (slurry).
  → Some clarification methods involve precipitation reaction.

- Uses of Ball Mill :- Ball Mill is used to reduce the particle size of drugs.
  It is based on the principle of impact and attrition.

- filter aid with example :- It forms a surface deposite when screen out the solids and also prevent the plugging of the the supporting filter media. eg. Talc, Charcoal, Asbestos etc... (3)

Attrition :- In this method, Drug particles collide with each other and reduce there size from large molecules to small molecules
eg fluid energy mill.

- Normal size of aperture in seive :-
Range is about 75 mm to 75 µm.
Apertures are square and are normally expressed in metric measure. (mm, microns, µm etc).
The aperture size is shown on a metal plate affixed to the side of each seive and typically ranges from 75 mm to 75 µm depending how coarse or fine the test sample is.

- flash Distillation :-
In which, we pass the entire liquid mixture from heater and increase the temp. upto their boiling point, so mixture is suddenly vapourized. (flash). and when we pass it in high pressure zone to a low pressure zone through pressure reducing pump.
So, Vapour become cool and convert into liquid.

--free moisture content :-
The free moisture content of the solid in excess of the equilibrium moisture content.
• the moisture content is measured by :—

$$\% \text{ moisture content} = \frac{\text{weight of water in sample}}{\text{Weight of dry sample}} \times 100$$

(4) fluid statics
⇒ • It deal with the study of fluid at rest
eg. Hydrostatic pressure

-fluid dynamics
• It deal with the study of fluid in motion.
eg. surface tension.

(5) Attrition :- Drug particles collide with each other and reduce there size from large to small
Impact :- Drug molecules convert into small particles through any types of impact.

(6) Moderately fine powder :- A powder all the particles of which pass through a sieve with a nominal mesh aperture of 355 microns and not more than 40% by weight through a sieve with a nominal mesh aperture of 180 microns.

⑦

Sedimentation	Elutriation
• It is the process of allowing particles in suspension in water to settle out of the suspension under the effect of gravity.	• It is a process ~~of~~ for separating particles based on their size, shape and density, using a stream of fluid flowing in a direction usually opposite to the direction of sedimentation.

⑧

Drying	Distillation
• It is the process of removal of small amount of liquid by application of heat to obtain dry solid.	• It is the process of separation of component of a liquid mixture (purification of a liquid).

⑨ **Steam Distillation :-** It is used to separate high boiling substance from non-volatile Impurities. (immiscible liquid).

- Steam is used as a heat source in this distillation.

⑩

Dry Corrosion	Wet corrosion
• Occurs in the absence of moisture	• Occurs in the presence of conducting medium.
• Slow process	• Rapid process
• Involve direct attack of chemicals on the metal surface	• Involve formation of Electrochemical cells

⑪

Mixing	Blending
• In which same type of fibre/material mixed together.	• In which different type of fibre/material mixed/blend together
• Easy process	• Difficult process.
eg. (cotton + cotton)	eg. [Polyster + Cotton].

⑫ **Dead spot in Solid mixing :-**

In Solid mixing, During process there are some place in mixer where mixing is not take place and that particular space known as **dead spot**.

- ~~Deadly~~ Dead spot are mostly corner of mixer.

(13) Mechanism of Impingment & Entanglement

⇒ Impingment :- Solid having the momentum move (ठोकर) along the path of streamline flow and strike (imping) the filtermedia. so that solid retain on the filter.

Entanglement :- Particles become entangled in the (उलझना, फसना) mass of fibres due to smaller size of particles than pore size, thus the solids are retained on filter medium.

(14) Under-driven and over-driven Assembly :-

It is the assembly of basket in centrifuge

- If basket is mounted above the driving shaft then this arrangement is known as Under-driven.
- If basket is suspended from a shaft then it is known as over-driven.

(15) Poiseiulle's equation

⇒ Used to know the rate of flow of fluid in filtration.

- Acc. to this filtration is similar to the streamline flow of a liquid under pressure through capillaries.

$$V = \frac{\pi \Delta P r^4}{8 L \eta}$$

where, V = rate of flow.
ΔP = Pressure difference
r = radius of capillary
L = thickness of the filter cake
η = viscocity of the filtrate.

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Totally Solve Important Questions of Pharmaceutical Engineering

Unit-I st

Q-1→ Describe in details about Reynolds number ?

Ans:- **Reynold's number :-** It is the ratio of inertial forces [which increase reynolds number] and viscous forces [which resists].

$$Re = \frac{\rho v d}{\eta}$$

$$Re = \frac{\text{Inertial forces}}{\text{Viscous forces}}$$

Where,

ρ = density of the fluid.
v = Velocity [Speed].
d = diameter of the pipe.
η = Viscocity of the fluids.

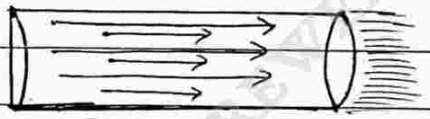
→ It gives that flow is steady or turbulent.
→ If $Re < 1000$, then flow is steady.
→ If $Re > 2000$, then flow is turbulents.

So, it is used to predict the nature of fluids. Also used to study the sedimentation rate.

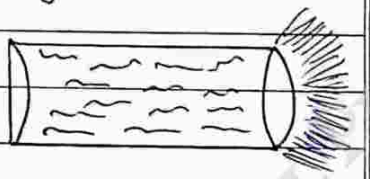
• **Flow Pattern:**

1- Steady flow.
2- Turbulent flow.

1)- **Steady flow** → A flow in which the velocity of the fluid at a particular fixed point does not change with time.
→ The liquid flow constantly.



2)- **Turbulent flow** → A flow in which the fluid undergoes irregular mixing, in contrast to laminar flow.
In turbulent flow the speed of the fluid at a point is continously undergoing changes in both magnitude & direction.
→ The liquid does not constant flow.



• **Applications of Reynold Number:**

→ It is used to predict the nature of the flow.
→ It is also used in scaling of fluid dynamics problems.
→ It is in determining the transition point between laminar & turbulent flow.

- **Significance of Reynolds Number :**

$$Re = \frac{\rho v d}{\eta}$$

Where,
ρ = density of the fluid.
V = Velocity.
d = diameter of the pipe.
η = Viscocity of the fluids.

→ The Reynolds number as the ratio of inertial to viscous effects.

- At low Reynolds number,
→ Viscous effect is comparable to inertial effect.
→ flow behaves in orderly manner.

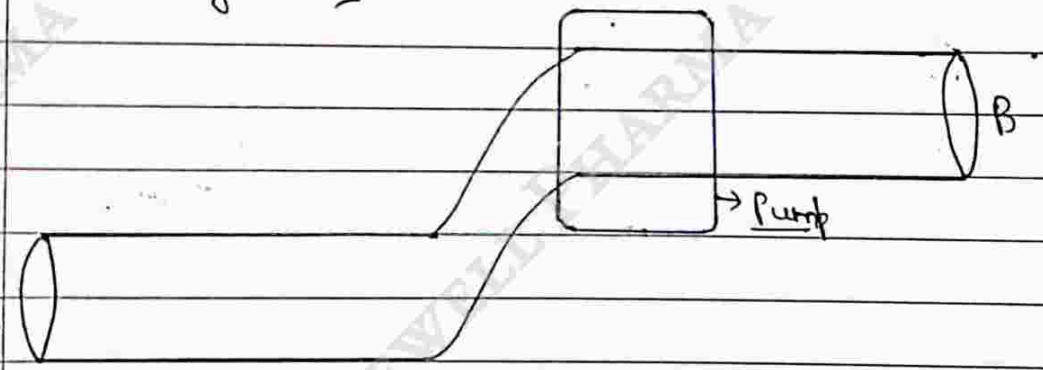
- At high Reynolds number,
→ Viscous effect is insignificant compared with inertial effect.
→ flow pattern is irregular, unsteady & random.

Q.2: State and ~~Drive~~ derive Bernoulli's theorem ?

Ans:- The total mechanical energy of the moving fluid comprising the ~~energy~~ gravitational potential energy of elevation, the energy association with the fluid pressure and Kinetic energy of the fluid motion remains constant.

$$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$$

Where,
P = Pressure exerted by the fluids.
V = Velocity of the fluid.
ρ = Density of the fluid.
h = Height of the container.



$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

- **Application of Bernoulli theorem :**

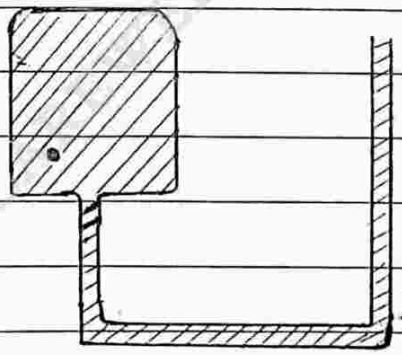
The Bernoulli's equation forms the basis for solving a wide variety of fluid flow problems such as jets issuing from an orifice, jet trajectory flow under a gate and over a weir, flow metering by obstruction meters, flow around submerged objects, flow associated with pumps & turbines etc.

Q-3:- Write the principle and working of manometer ?

Ans:- **Manometer** → It is a device which is used to measure the pressure difference.

- **Working** → In the manometer, one end connects to a gas-tight seal to test the pressure source. In addition, the other end of the tube is left open to the atmosphere and it will be subjected to the pressure of approx one atmosphere.

e.g.,



Besides, the test pressure is greater than the pressure of 1 atmosphere the liquid in the column will be forced down by the pressure. Further more, it will cause the liquid of the reference column to rise by an equal amount.

- Principle → A manometer is a device for measuring fluid pressure consisting of a bent tube containing one or more liquids of different densities. A unknown pressure is applied to one end of the manometer tube and the unknown pressure is applied to the other end.
Manometer operates on hydrostatic balance principle. When a manometer is connected to a process, the liquid in the column will rise or fall according to the pressure of the source it is measuring. In order to determine the amount of pressure, it is necessary to know the type of liquid in the column, and the height of the liquid. The quality of the fill liquid will also effect the accuracy of pressure measurements. The fill liquid must be clean & have a known specific gravity.

Q-4→ Write the principle, construction and working of Venturimeter?

Ans= It is used to measure the rate of flow of the liquid in a pipe.

- Principle → It is a based on the Bernoulli's theorem.
→ It consists of two tapered section in the pipeline with a gradual constriction at its centre.
→ When fluid is passed through venturi meter, their are change in the pressure head and increase in velocity due to constriction of venturimeter. [Acc. to Bernoulli].
→ By this formula:

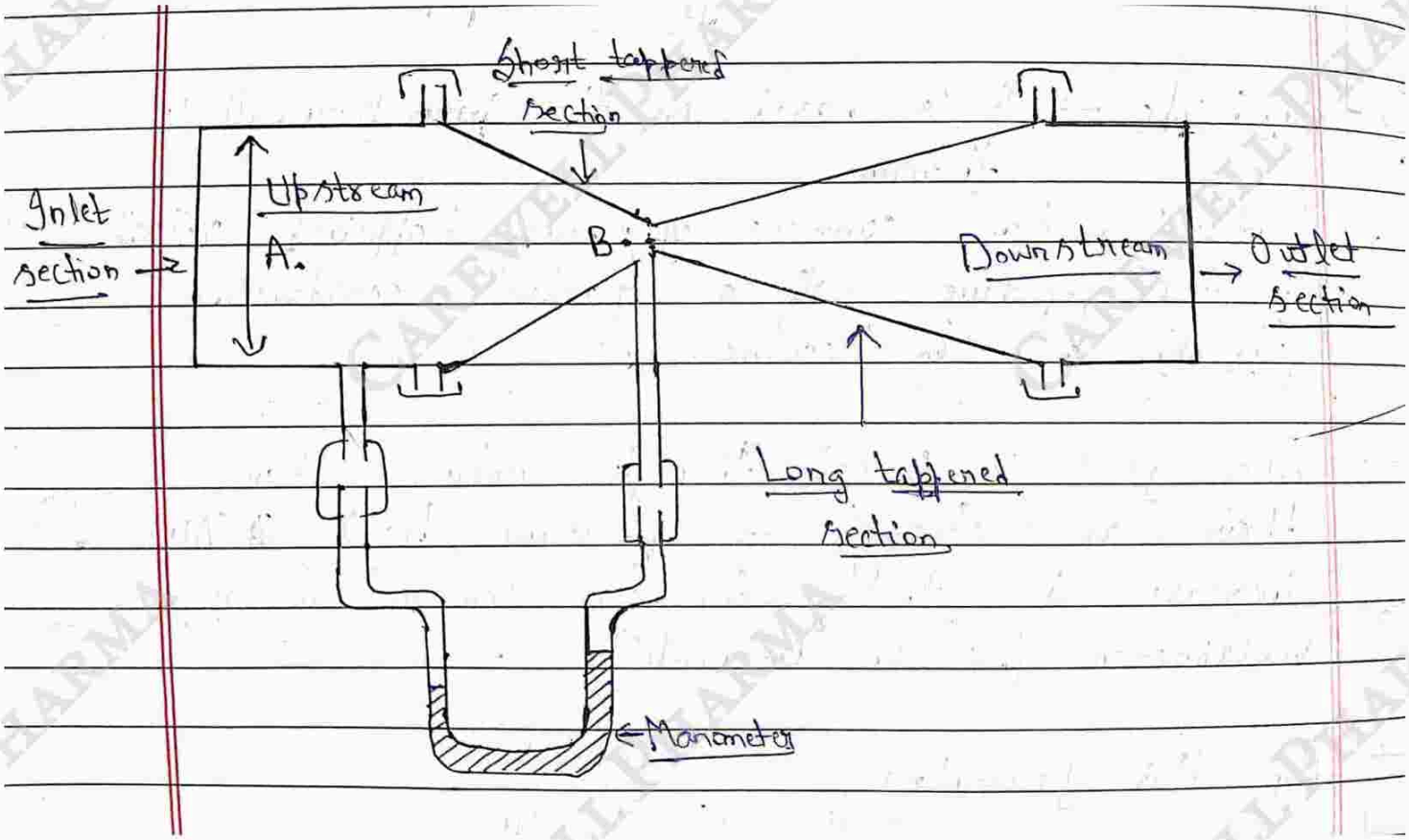
$$U_V = C_v\sqrt{2g.\Delta H}$$

We can easily find out the velocity of the fluids.

Construction:

→ It consits of two tapered section inserted in a pipeline with constriction at meter's centre.

→ The upstream cone is normally shorter than the downstream.



→ The tapers are smooth & gradual.
→ A manometer is connected at point A & B to measure the pressure difference.

• Working :

→ Firstly venturimeter is inserted b/w pipeline.
→ When a fluid is passed through venturimeter, the velocity of the fluid is increased at the throat, due to the constriction.
→ This result is decreased pressure in the up-stream cone which further calculated through manometer.
→ Now,

$$\boxed{U_v = C_v\sqrt{2g.\Delta H}}$$

Where,
U_v = Velocity of the fluid through venturimeter.
C_v = Coefficient of the venturimeter.
ΔH = Pressure difference.

→ Now, put the value of ΔH [which is measured in manometer] in this equation and find the velocity of fluid.

Q-5:- Write a note on various laws governing size reduction?

Ans:- There are 3 law governing are:
1:- Kick's law.
2:- Rittinger's law.
3:- Bond's law.

1):- **Kick's law** :- The energy required to reduce the size of particles is proportional to the ratio of the initial size of a typical dimension to the final size of that dimension.

$$E = K_K \ln \left[\frac{d_1}{d_2} \right]$$

Where,
E = Energy
K_K = Kick's constant.
d_1 = diameter of initial particles
d_2 = diameter of final particles.

2):- **Rittinger's law** :- The energy required for size reduction of unit mass is proportional to the new surface area produced.

Remarks

Teacher's Signature

$$E = K_x \left[\frac{1}{d_1} - \frac{1}{d_2} \right]$$

Where,
E = Energy
K_x = Rittinger's law.
d_1 = initial size.
d_2 = final size.

3) Bond's law → In this, energy used for size reduction is proportional to the new cracks length.

$$\frac{E}{W} = \sqrt{\frac{100}{d_2}} - \sqrt{\frac{100}{d_1}}$$

Where,
E = Energy
W = The bond work index work require to reduce a unit weight.
d_1 = Diameter of the seive aperture that allow 80% of the mass of the feed to pass.
d_2 = Diameter of the seive aperture that allow 80% of the mass of the ground material to pass.

Q-6 :- Describe in details about Fluid Energy Mill ?.

Ans :- **Fluid Energy Mill** :- In which, reduce the particle size through Attrition & Impact.

- **Principle** :- It works on the principle of Attrition & Impact.

- **Construction** :-

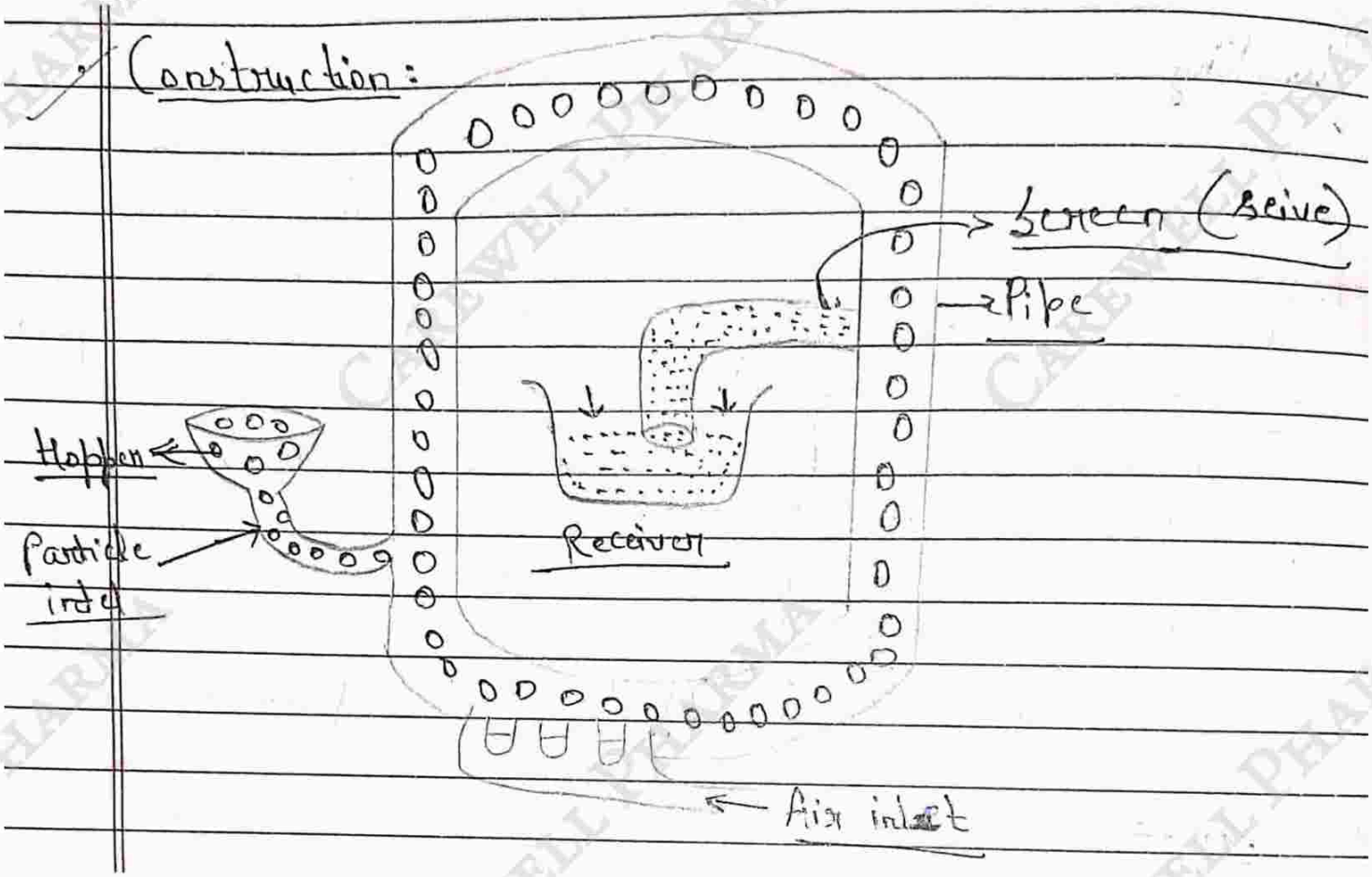
:- It consists of a loop of the pipe, which has a diameter of 20 to 30mm & Overall height of the loop, which may be upto about 2 meter.

:- There is a Hopper for inlet of the particles which we have to reduces & one inlet for air or any inert fluid.

:- And one outlet from where we get [received] reduced particles.

- **Working** :-

:- Firstly solid particles [drug particles we have to reduced] introduced into pipe through hopper then close it.



→ Then, air introduced into pipe through air inlet with very high pressure.
→ Due to high degree of ~~tub~~ turbulence, impact & attrition forces occurs between the particles and the particles started to be smaller.
→ Then it will received in receiver passes through the screen.

• **Uses:**

→ The mill is used to grind heat sensitive material to fine powder.
→ It will reduces the particle to 1 to 20 microns.

• **Advantages:**

→ This mill is used to grind the material to fine powder.
→ There is no ~~cross~~ contamination of the product.

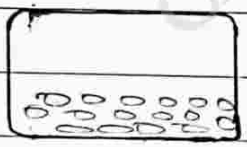
• **Disadvantages** → High energy consumption.
→ Generation of amorphous content due to high energy impact.

Q-7 → Describe in details about Ball Mill ?

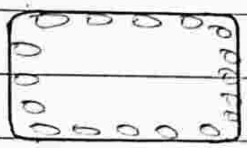
Ans → **Ball Mill** → Mill which used to reduce particle size through 'Impact' & 'Attrition'.

- **Principle** → It based on the combination of Impact & Attrition.
- **Construction**:

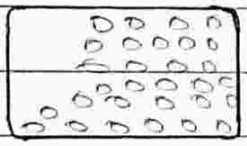
→ It is also depends on the speed.



→ Slow [can't work]



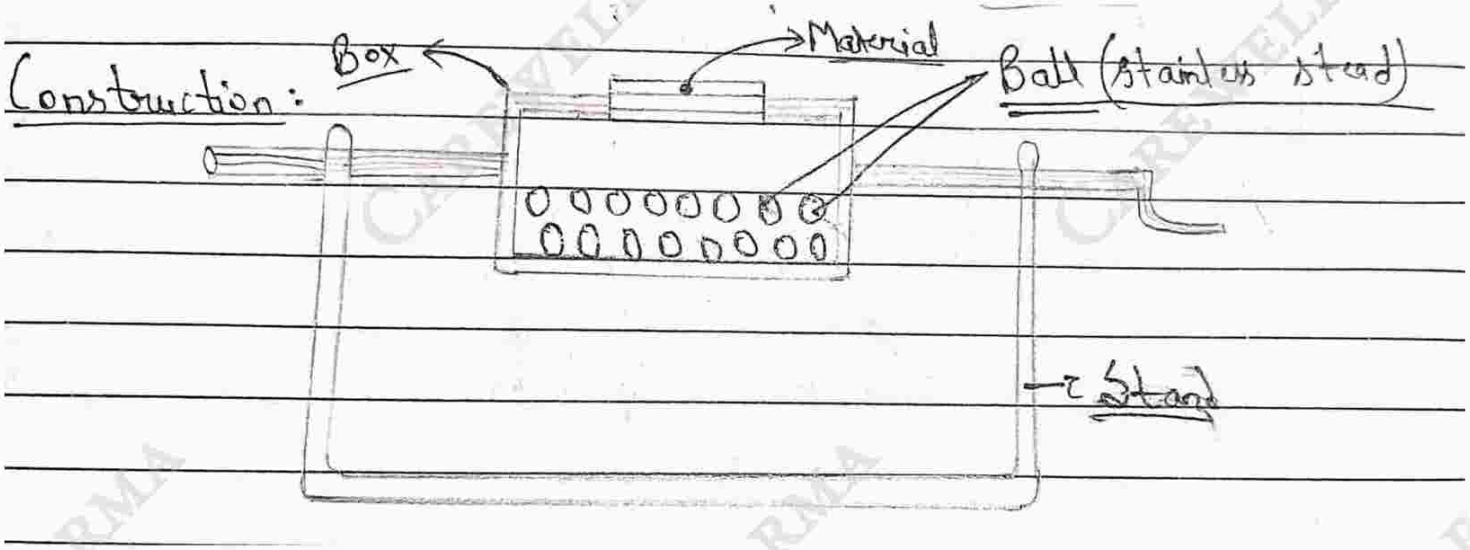
→ Fast [can't work]



→ Medium [Can work]

- **Working**:

→ Open the cap of the box & enter the drug molecules into it.



→ Then start the machine and adjust the speed of the mill.
→ One medium speed, it will start and reduce the particles size.
→ After reduction, stop the machine, then exist out the material.
→ And separate out the ball from particles.

• Uses:

→ It is used to reduce particles size through impact and attrition.

• Advantages:

→ Without noise.
→ Neat & clean.
→ Less energy used.
→ All types of particles reduce easily.

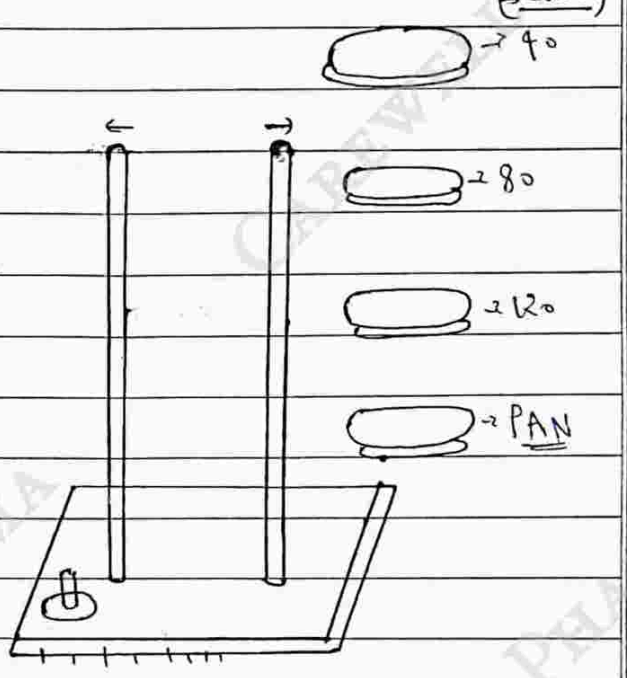
• Disadvantages → Can't reduces fibrous material.
→ Not reduces in very big amount of the particles.

Q-8→ Describe in details about Seive shaker for size separator ?

Ans→ **Seive Shaker :**

- **Principle →** It is based on the principle of Agitation, in which seive will be shake it.

- **Construction :**



→ It consist a machine with different seive number's seive.
→ One PAN (receiver) in which we get very fine powder or our product.
→ One switch which start it for vibrating & device is mainted with surface.
→ And two long ~~rods~~ rods in which seive will be fixed.

Working :

→ Firstly fixed all the seive into device according to one need.

→ Then start the machine, powder will be automatic separated out acc. to their seive sizes.
→ Then collect it & use it.

• Uses:

→ Used for separate out many sizes at same time.

• Advantages:

→ It is simple and easy in use.
→ We can separate out many size drug particles at the same time.

• Disadvantages:

→ It is cannot separate out in large amount.
→ It is used as a small scales.

Q-9: Write a short note on official standard of powder on seive sizes?

Ans: It is also known as Grading of the powders.

→ This is the number of partition in any Seive.
• Seive number are increase then Particle Size is decreased.

Very Coarse	8 ↓ 100%	60 ↓ 20%
Coarse	20 ↓ 100%	60 ↓ 40%
Moderatory Coarse	40 ↓ 100%	80 ↓ 40%
Fine Powder	60 ↓ 100%	100 ↓ 40%
Very fine powder	80 ↓ 100%	

(i) → Very Coarse → These are those powders which can pass 100% from Seive no. 8 & only 20% pass from Seive no 60, then it is called very coarse powder.

(ii) → Coarse Powder → These are those powders which can pass 100% from Seive no. 20 & only 40% pass from Seive no. 60. it is called coarse powder.

(iii) Moderatory Coarse → There are those powders which can pass 100% from Sieve no. 4 & only 40% pass from Sieve no. 8, then it is called moderatory coarse powder.

(iv) Fine Powder → There are those powders which can pass 100% from Sieve no. 60 & only 40% pass from Sieve no. 100, then it is called fine powder.

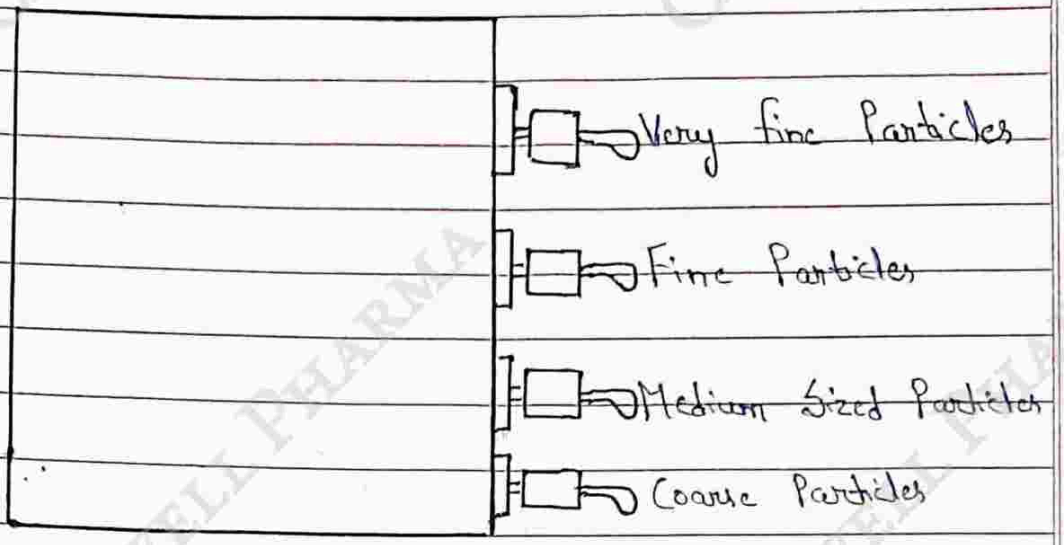
(v) Very fine Powder → There are those powders which can pass 100% from the Sieve no. 80., then it is called very fine powder.

Q-10 Write a short note on Elutriation Tank.?,

Ans → Elutriation Tank : It is also known as Elutriation method.

- Principle → It is based on the principle of ~~Setling~~ Sedimentation.

- **Construction:**



- **Working:**

It is used to separate the coarse and fine particles of powders after levigation.

The dry powder or paste made by levigation process is kept in an elutriating tank and mixed with a large quantity of the water. The solid particles are uniformly distributed in the liquid by stirring then it is allowed to settle down. Depending upon the density of the solid particles, it will either settle down or remain suspended in the water.

→ The sample is withdrawn at different weights through the outlets. These are dried & thus the powder with various size fraction are collected.

• Uses:

It is used for separation of different sizes, & we can get more and more separation because it is a continous process.

• Advantages:

→ Separation is quick as compare to other method of separation.

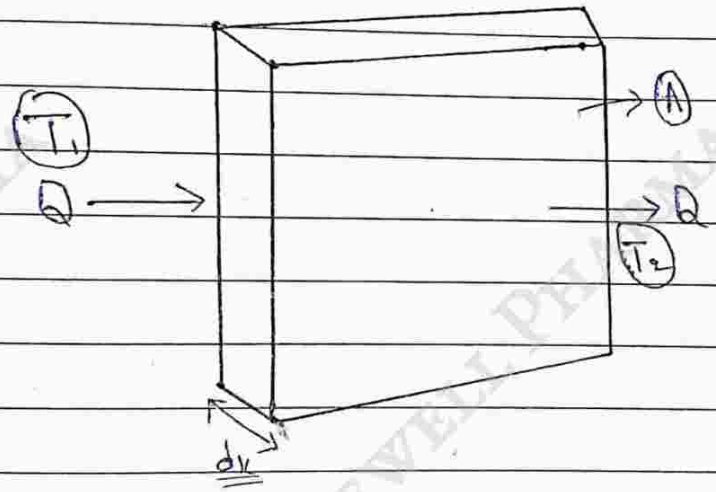
→ Depending upon the number of the fraction required, same number tubes of different area of cross section can be connected.

• Disadvantages: Sometimes the suspension of the solid particles has to diluted which may not be desired in certain cases.

Unit-IInd

Q-12 What is the Fourier's law? Write in details.

Ans = **Fourier's law** → It is depend upon the Conduction. It states that "the rate of the heat transfer is directly proportional to the area normal to the direction of the heat flow and temperature gradient" and inversely proportional to the width of the wall of from which heat transfer.



- **Temperature gradient** → It is the difference of the temperature from one place to another place (dt) is called temperature gradient.

→ Temperature gradient is also known as driving force.

- According to law;

$$Q \propto A$$
$$Q \propto dt$$
$$Q \propto \frac{1}{dx}$$

So,

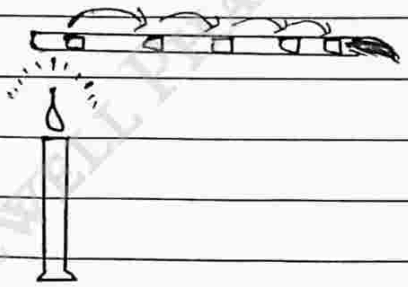
$$Q \propto \frac{A \cdot dt}{dx}$$

$$\therefore \boxed{Q = \frac{-KA \cdot dt}{dx}}$$

Where,
Q = Rate of change of the heat transfer.
A = Area of the wall.
dt = Change in the temperature.
dx = Thickness of the wall.
K = Constant [proportionally constant].
Negative sign indicates the drop in temp. from high conc. to low concentration.

Q-2:- Describe in details about the heat transfer?

Ans:- Heat Transfer :- It is the form of the energy and when it transform from one place to another place it is called heat transfer.



→ It transferred through medium [solid & liquid].

→ And it may be also transfer through surrounding [air].

→ It involves 3 process:

1:- Conduction.
2:- Convection.
3:- Radiation.

1) :- Conduction :- In this heat transfer in a solid in series in heat, particles are directly connect with each other and heat transfer through

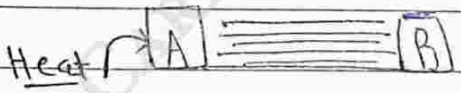
one by one.
→ In this, particles must be stationary.
→ Heat transfer temperature gradient [difference of temp.].
→ Heat transfer from high temp. to low temp.

2)→ Convection → It is the transfer of heat through the movement of liquid [fluid].
→ In which, initial position is particle absorb heat then displace with final's position's particles.

3)→ Radiation → In which, heat directly transfer without any medium [use surrounding air].
→ Electromagnetic waves.
e.g. Sun is heat to water for vapourisation.

Q-3→ Write short note on mechanism of heat transfer?

Ans→ Heat transfer → It is the form of ~~heat transfer~~ the energy and when it transform one place to another place is called heat transfer.



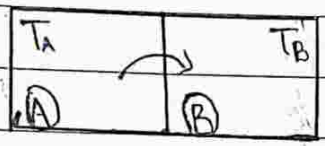
- **Mechanism of Heat Transfer :**

It involves three process :

1. Conduction.
2. Convection.
3. Radiation.

1) → **Conduction** → Transfer of heat through a solid material, it may be through fluid, but fluid should be stationary.

→ It also depends upon temperature gradient, because heat transfer from high temp. to low temp.

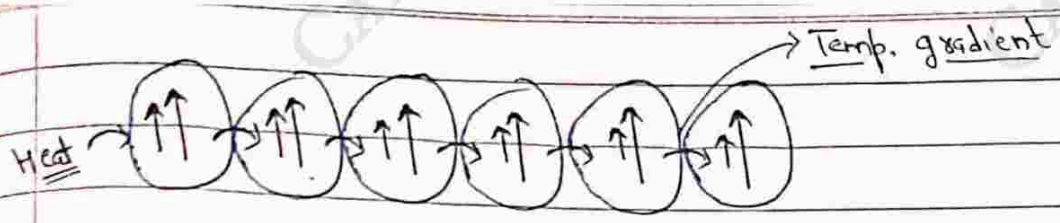


$T_A > T_B$

→ Now,

When we provide heat at one end of substance, then particles of that end vibrate vigorously and then they collide with neighbouring particles and transfer their energy.

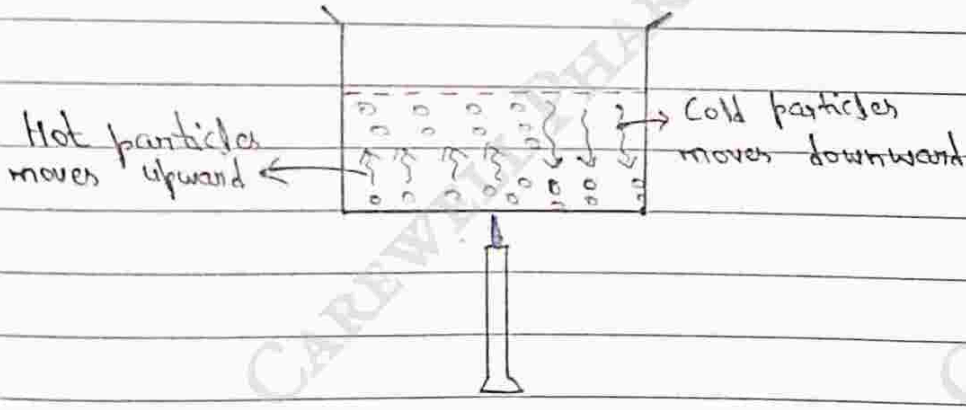
→ This process should be continously untill the last end particles should absorb heat.



Rate of heat transfer $\Rightarrow$ $\frac{\text{Driving force}}{\text{Resistance}}$

- Driving force → Jo which is responsible for heat transfer.
- Resistance → Jo which resist some heat in heat transfer.

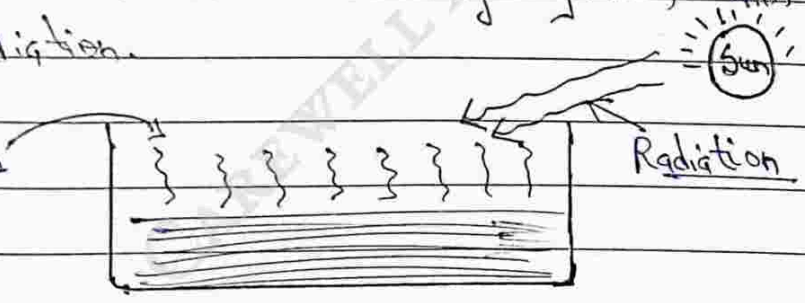
2). Convection → It is the mode of heat transfer which occurs mostly in liquids and gases. In this method, heat transfer take place with the actual motion of the matter from one place within the body to the others.



→ When we boil water we have seen bubbles and currents develop in water on careful observations.
→ It is example of convection, in which hot water at bottom become lighter and moves upward, forcing the cold and denser water at the top to come down and thus heated up.

3) → Radiation → It is the another form of heat transfer. It does not require any medium and it can be used for transfer of heat in a ~~vaccum~~ vacuum as well.
→ This method used electromagnetic waves which transfer heat from one place to other place.
→ The heat and light from the Sun in our Solar system reach our planet using radiation only.

e.g. In winter, when we sit near a fire we feel warm without touching fire, this is possible by radiation.



→ Radiation most potent.

Q-4-2 Write down the principle, construction & working of Climbing Film Evaporator?

Ans: Climbing Film Evaporator → It is also known as Rising Film Evaporator.

- Principle → In this, evaporation takes place through a tube, which are vertically fitted in cylinder.

→ Heat passed through steam in tubes and liquid outside the tubes absorb heat and become heated and convert into small bubbles, which climb upward.

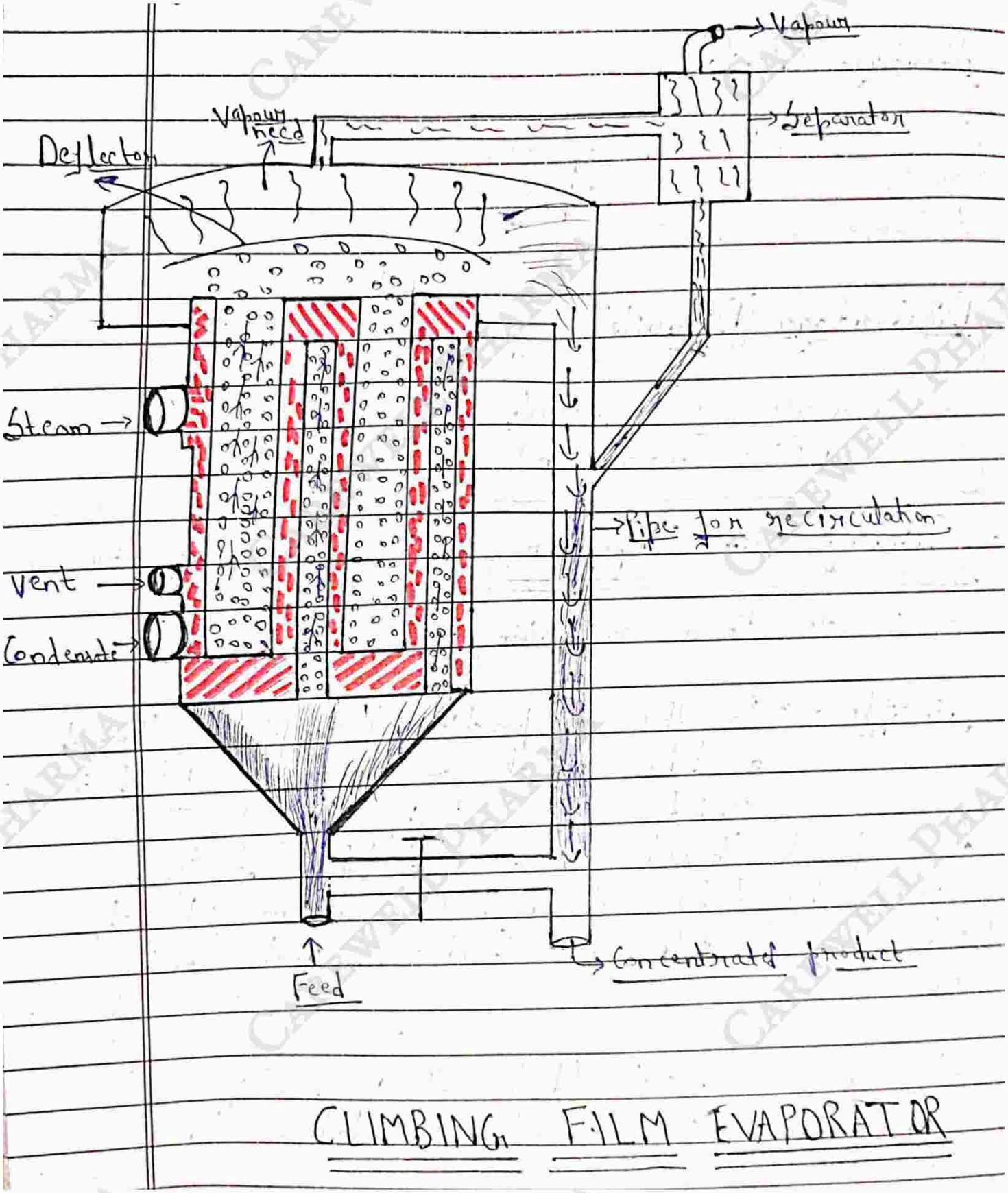
→ And vapours discharge from the apex [top] and concentrated liquid get at bottom by product outlet.

- ~~Consist~~ Construction:

→ It consist of steam Jacketed tube.

→ A deflector is placed at the top to the vapour head also condensate outlet for the steam and vent outlet.

→ Feed inlet from the bottom.



CLIMBING FILM EVAPORATOR

→ And one pipe for recirculation, which circulate feed again.
→ And at bottom one product outlet, from which we get product [concentrated].

• Working:

→ Pre-heated liquid feed is introduce from bottom and steam introduce [enter] into tubes.
→ Liquid absorb heat and started to make small bubbles which started to climb upward.
→ Then that bubbles separated through the deflector which is present on Vapour head.
→ And our liquid portion is passed in pipe for the recirculation and vapour goes into separator.
→ In which, vapour discharge from top and liquid recirculate.
→ And when liquid is concentrated product get from product outlet.

• Uses → It's used for clear liquids.
→ It's used for foaming liquids.
→ It's used for corrosive solution.

Q-5→ Write in details about Multiple effect evaporator & economy of multiple effect evaporation?

Ans→ **Multiple Effect Evaporator**

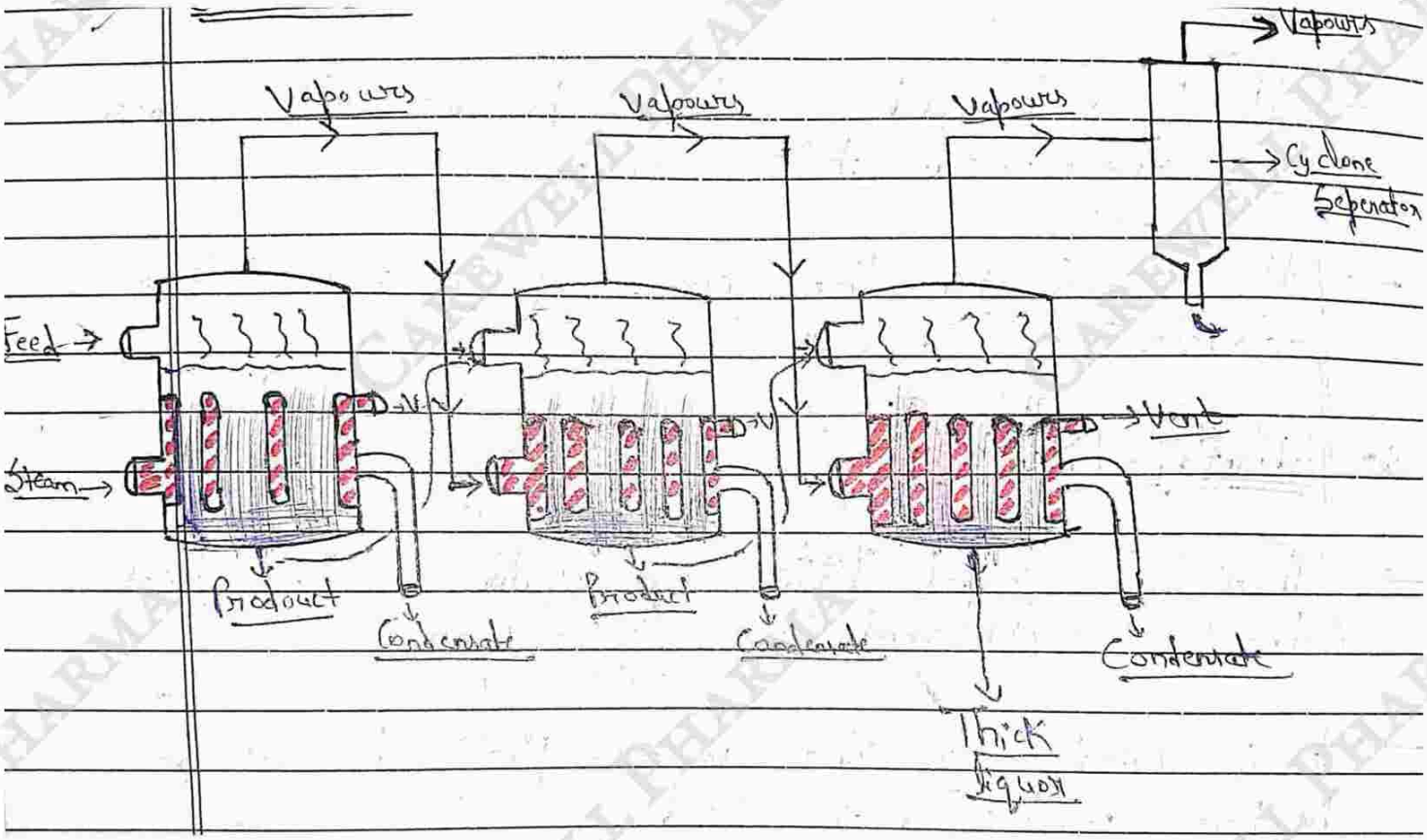
- **Principle** → In this evaporator, verticle tube evaporator are connected in series, it is used for large scale evaporation and also for higher concentrated product.

- It occurs in three steps:

(i)→ Pre-heating of solution.
(ii)→ Removal of water as vapour by steam heating.
(iii)→ Condensing the vapour removed.

- **Construction:**

→ It consist of three evaporators in a series.
→ In which, each evaporator consists of large cylindrical body [made up of cast iron].
→ First evaporator has one steam inlet and one for feed. and then first's evaporator is vapour outlet is attached with second evaporator steam inlet and same as second is attached with third.



→ In third evaporator their are one outlet in which we get highly concentrated product.
→ In which approx 100 tubes are fitted.
→ Each evaporate has condensate for steam.
→ And in last evaporate vapour is discharge in atmosphere through separator.

• Working:-

→ Firstly, pre-heated solution [feed] is enter in each evaporator upto the level of the upper tube sheets.
→ The hot steam is enter in first evaporator and it supply continued until desired pressure is created in steam space of first evaporator.
→ And heat transfer from steam to liquid, during this also some steam is convert into condensate, which is remove from condensate outlet.
→ By absorbing heat, liquid temp. ↑ises and its started to converted into vapours.
→ And these formed vapours move to steam of second evaporator and work as a steam.
→ Then, the vapour of first evaporator transmit its heat to the liquid of second evaporator and then condensate removed through condensate outlet.
→ The same happened in third evaporator.

→ And steam is continous supplied until heat is same in all three evaporators.
→ And evaporator's product outlet is also connect in next's evaporator feed inlet.
So, feed is constant in all evaporators.
→ The process is continued, until liquid in evaporators reaches the desired viscocity.
→ And final concentrated product collected from third evaporator outlet.
→ And remaining vapour is discharge or separated through separator, which is connect with third evaporator.

Q-6- Write short note on:
i)- Factors influencing evaporation.
ii)- Differences b/w evaporation & other heat process.

Ans i):- Factors Influencing Evaporation:

1- Temperature.
2- Surface Area.
3- Vapour Pressure.
4- Humidity.
5- Wind Speed.

(i) Temperature → Temp. ∝ Rate of Evaporation.

As the temperature ↑ises, then rate of evaporation also ↑ised with ↑ised in temperature.

(ii) Surface Area → S.A. ∝ Rate of Evaporation.

As the surface area ↑ises, then rate of evaporation also ↑ised with ↑ised in surface area.

(iii) Vapour Pressure → V.P. ∝ Rake of Evaporation.

As the vapour pressure of liquid ↑ises, then rate of evaporation also ↑ised with ↑ised in vapour pressure.

(iv) Humidity → Humidity ∝ 1/Rate of Evaporation.

As the humidity in atmosphere ↑ises, then rate of evaporation ↓ised.

(v) Wind Speed → W.S. ∝ Rate of Evaporation.

As the wind speed ↑ises, then rate of evaporation also ↑ised.

Ans(ii) Differences b/w Evaporation & Other heat process :

EVAPORATION	Other Heat Processes
→ The residue is concentrated liquid.	Drying → The residue is solid.
→ Transforming liquid into a gas [no need to separation].	Distillation → It's the process of separation [separation is compulsory].
→ Purpose is to get concentrated liquid.	Crystallization → Purpose of concentrating solution to get crystals.
→ Liquid into Gas..	Sublimation → In this, solid into gas.
→ It happened also on room temperature.	Boiling → Process of evaporation, of a liquid at boiling point of the liquid.

Q-7 → Write short note on :
i) → Horizontal tube evaporator.
ii) → Forced Circulation evaporation.

Horizontal Tube Evaporator:

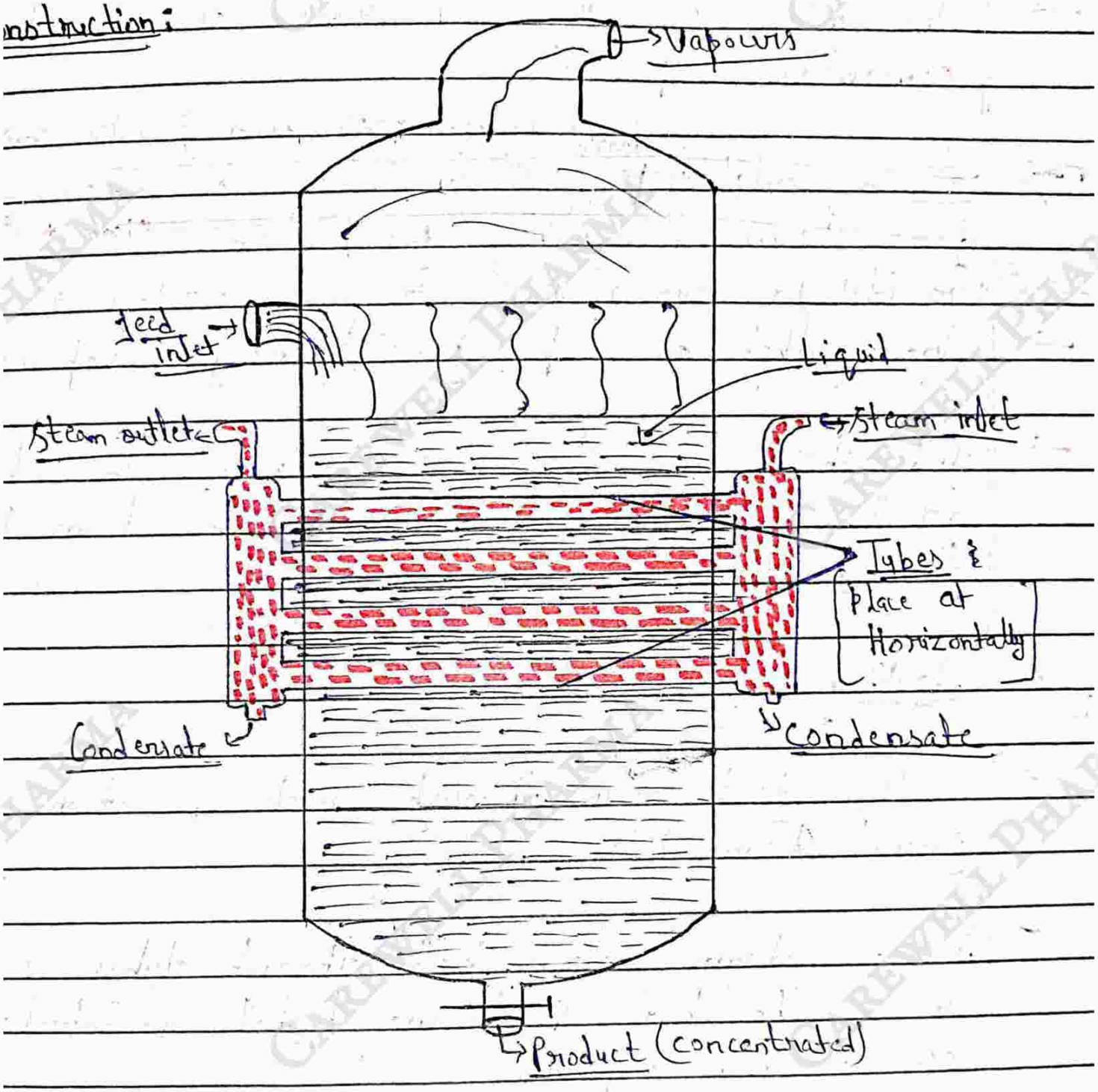
- **Principle** → In this, evaporation takes place through a tube, which are horizontally fitted.

→ Steam passed through tubes and liquid outside the tubes get heated by absorbing heat and convert into vapours and pass out from top (apex).

- **Construction:**

→ It consist of a large cylinder body in which, some tubes are fit in between cylinder horizontally.
→ It's made up with cast iron.
→ It's about 1.8 to 2.4m wide & 2.4 to 3.6m long.
→ One inlet for feed & outlet at downside for concentrate products.
→ Steam inlet for steam enter and also condensate for steam outlet.
→ One outlet at top for discharge vapours.
→ And this are steam compartment in which, 6 to 8 tubes placed horizontally and steam passed through it.

nstruction :

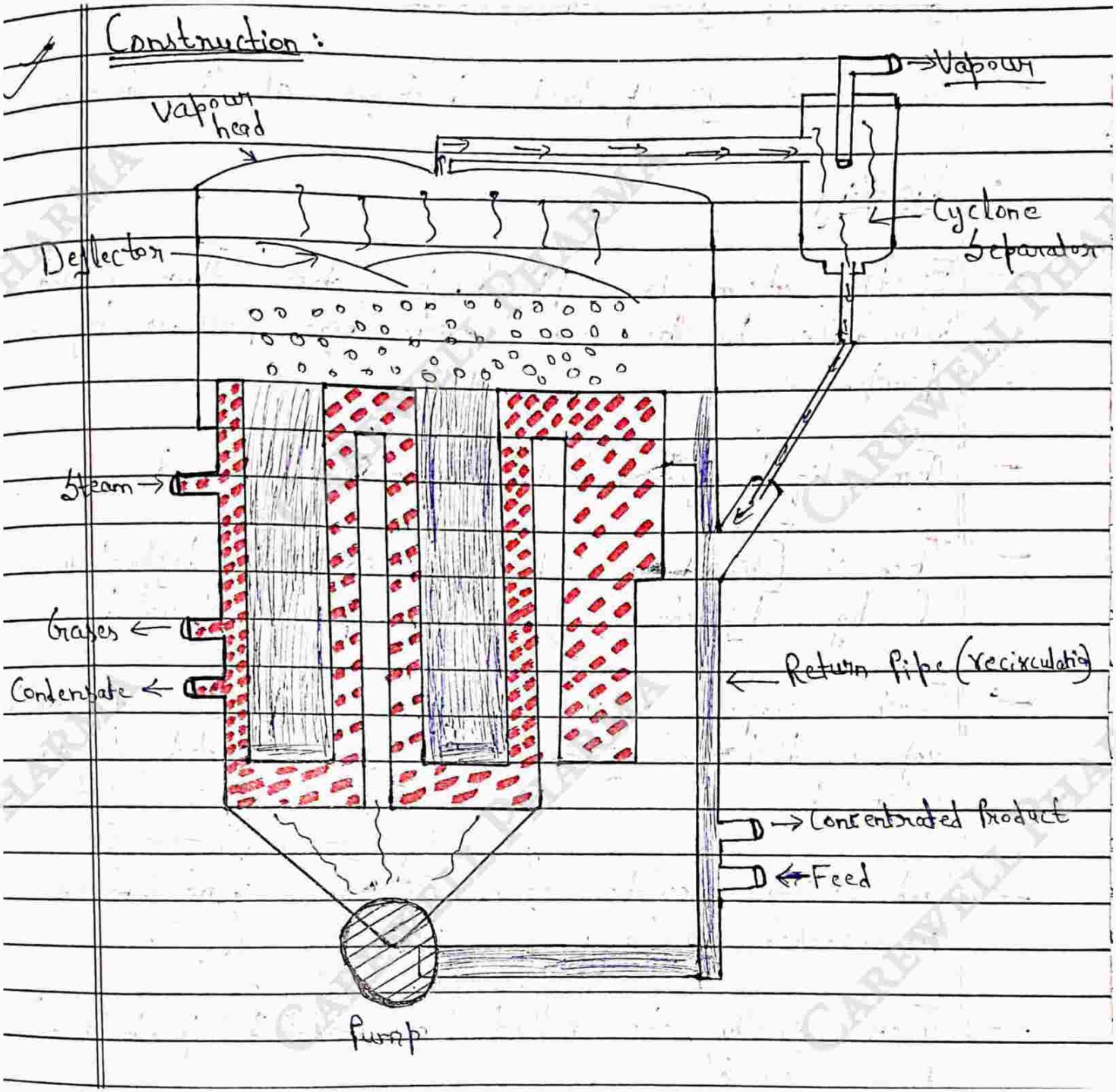


• Working :-

→ Firstly feed enter through inlet and steam enter from steam inlet.
→ Now, steam release heat through tubes and liquid absorb that heat and become heated & started to convert into vapours.
→ Vapours is escape from outlet at top.
→ Process continue until we get the concentrated product, which we want.
→ And then product is collected through outlet at bottom.

Ans(ii) Forced Circulation Evaporator

• Principle → In this, liquid is circulated through tubes at high pressure by using pumps. And due to high pressure boiling does not take places because boiling point is elevated. And liquid also create some form of agitation. When leave the liquid from the tubes and enters the vapour head, pressure falls suddenly. This lead to the flashing of super heated liquor, thus the evaporation occurs.



→ One centrifugal pump.
→ Steam jacketed tubes are held b/w two tubes sheets.
→ Tube measure → 0.1 meter diameter.
2.5 meter long.
→ A vapour head with deflector and one cyclone separator which separate vapour and discharge on top from the liquid.
→ An ~~outle~~ outlet for the product discharge at the bottom.

• Working :
→ Firstly steam is supplied in tubes, then liquid introduce to the tubes with high pressure by the pump.
→ Then liquid get heated & move upward.
→ Then it [liquid or vapour] strikes the deflector & by deflector liquid or vapour separated.
→ Further vapour enter in cyclone separator, in which vapour discharge from top and concentrated liquid fallen down.
→ And it recirculate again, if we want more concentrated product. then finally we collect concentrated product from an outlet.

Q-8 Describe in details about : [Any one or two].

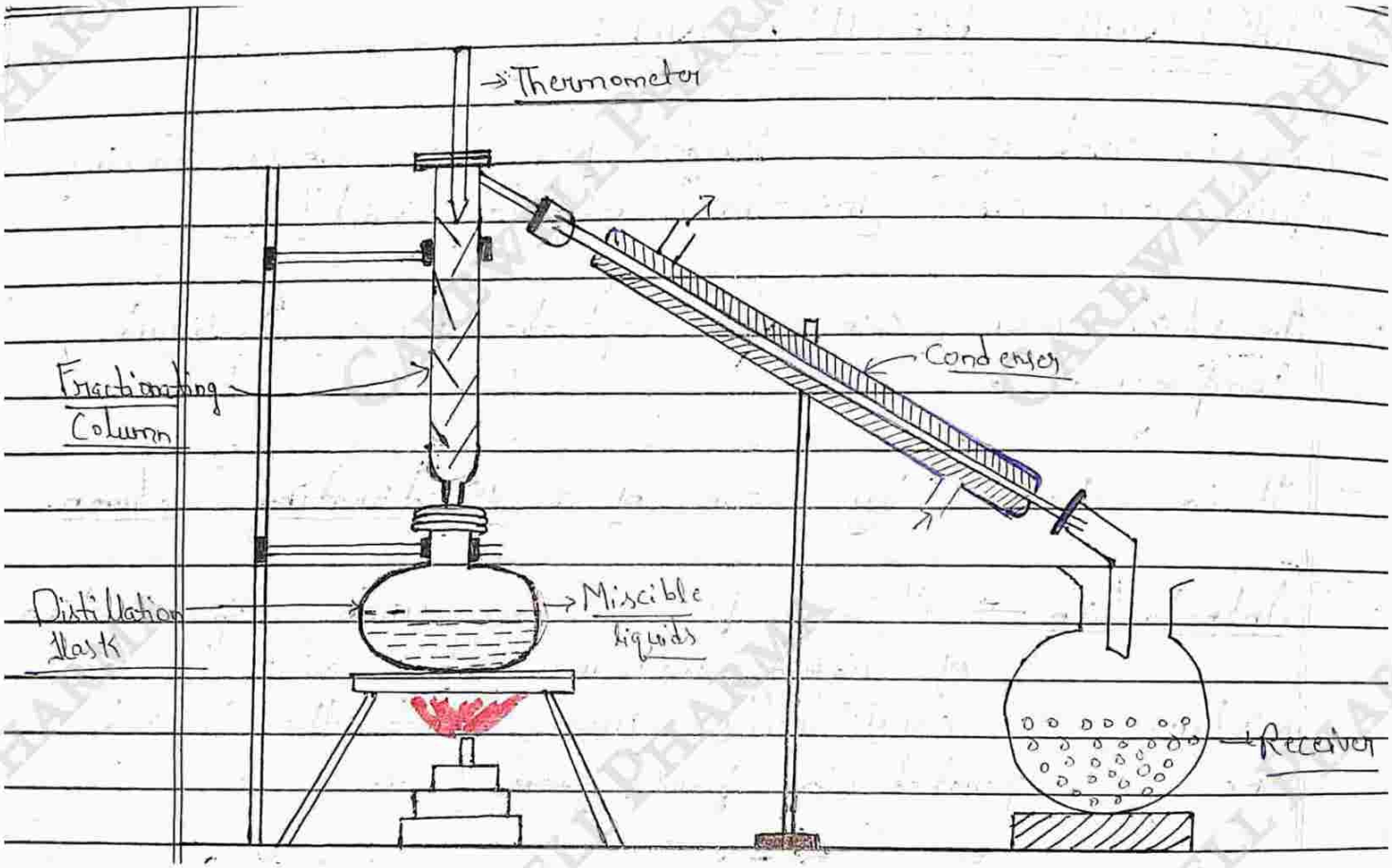
(i) Fractional Distillation

→ It's used for separate for those whose boiling point are very close [miscible volatile liquids].
→ In which, we can also separate ~~more~~ two or more liquids components mixtures.
→ It is separated by means of a fractionating column.

- Introduction → It is a process in which vapourization of liquid mixture gives rise to a mixture of constituents from which the desired one is separated in pure form.

- Principle → When a liquid mixture is distilled partial condensation of vapour is allowed in a fractionating column.

Now, that liquid's vapour which boiling point is slightly low than other is pass out from fractionating column and through condenser it ~~reduce~~ receive in receiver, while other liquid is condensed in fractionating column and return back in distillation flask/ Round bottom flask.
→ Now, we change the receiver and by applying same process, we also collect 2nd liquid in pure form.



- **Construction:**

- In this, one burner, round bottom flask, condenser, receiver, & & fractionating column b/w round bottom flask and condenser.

- **Methodology: [method & working].**

- Firstly take a mixture of the miscible liquid mixed in distillation flask.
- Liquid mixture has low boiling point difference.
- There are an fractionating column that effected continously to condensation & re-vapourisation.
- Now after introducing mixture on flask start providing heat.
- Now, their are some distance in boiling point.
- So, on heating all the liquid mixture convert into vapours and start moving upward.
- Now, those boiling point is less move upward first and other liquid's vapour is below from it.
- So, on moving upward from fractionating column, low boiling point liquid's vapour passes easily enter [because it is upward] into condenser & collected into a receiver.

→ And Second liquid, vapours [high boiling point] condensed in fractionating column and return back into a flask.

→ After ~~collect into~~ receiver, change the receiver and we collect it, and other's liquid is left in flask.

→ If we want it in pure form, then repeat this, and heat provide is slightly more than before & also collect it from second receiver.

• Uses :- → It's used for those liquid's mixture, whose boiling point is not for different.

e.g., [Benzene 80.1°C + Alcohol 78.37°].

[Air → O_2 183°C + N_2 196°C + Ar 186°C]

→ It is used to separate out components from these mixtures.

2.2 Steam Distillation :

→ It is used to separate high boiling point from non-volatile impurities (immiscible liquids).

• Principle →

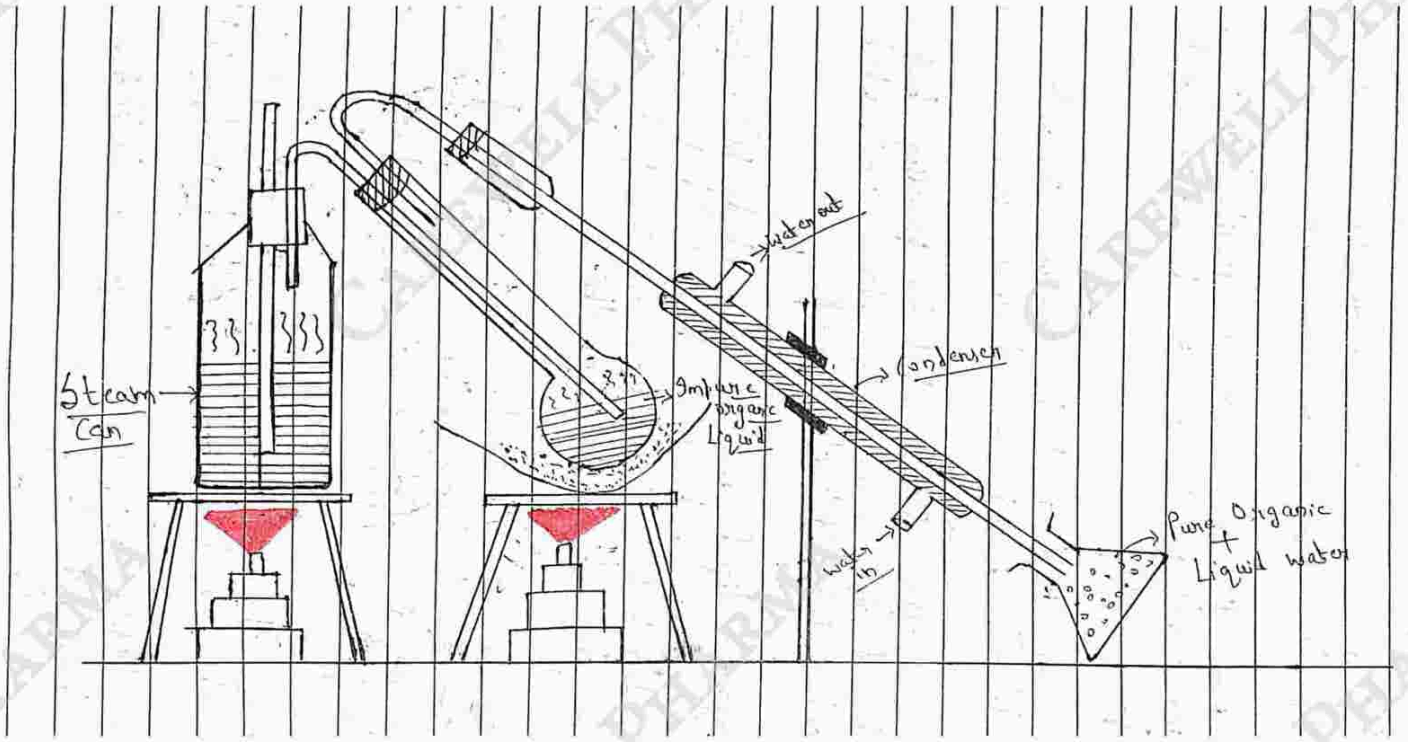
→ A mixture of immiscible liquid begins to boil when sum of their vapour pressure is equal to the atmospheric pressure.

$$\boxed{V.P. = A.P}$$

→ It is happened because steam has also some boiling point and vapour pressure, which mix the pressure of the organic substance and reach to its atmospheric pressure and liquid convert into vapours.

• Construction :

→ Metallic steam can fitted with cork having two holes.
→ Safety tube inserted upto bottom through one hole to maintain the pressure inside steam can, more over when steam comes out from safety tube indicates that can is empty.
→ Through other ~~tube~~ hole bent tube is passed and other end of this tube is connected to the flask containing liquid mixture in which tube is dipped.



→ Flask & condenser is connected with delivery tube.
→ Condenser is connected to the receiver.
→ Provision are made to heat ~~both~~ both steam can and flask separately.

• Methodology:

→ Firstly fill water in steam can and set all apparatus according to their construction.
→ Then fill impure organic liquid [organic liquid + non-volatile impurities] in distillation flask with some water.
→ Organic liquid must be insoluble in water.
→ Now, after setup, start to providing heat and steam also created on steam can, which further enter into distillation flask.
→ Organic liquid mixture has high boiling point, so it get some heat from burner's heat and if we provide heat upto their boiling point, it may be decompose, because these are heat sensitive.
→ So, these liquid mixture get vapour pressure from steam and it mix with steam and their vapour pressure is equal to the atmospheric pressure at low temperature.
→ Now, these mixture converts into vapours and pass through condenser and receiver into receiver.

→ ~~Non~~ Non-volatile impurities is left in distillation because it does not convert into vapours.
→ Product [water + pure organic substances] which we collect in receiver is separated through separating funnel [insoluble].

• Uses:

→ It's used for the preparation of Aromatic water.
→ It's used to extract volatile oils like clove.,
→ It's used to separate immiscible liquids.
eg, [Water + Aniline].

→ It is used purification of essential oils like almond oil also for some organic liquids.

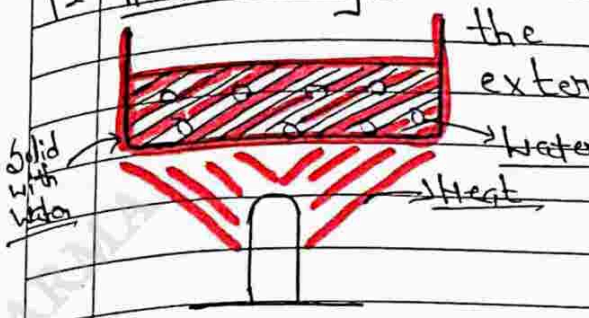
Unit: III

Q-1→ Write a note on mechanism and theories of drying?

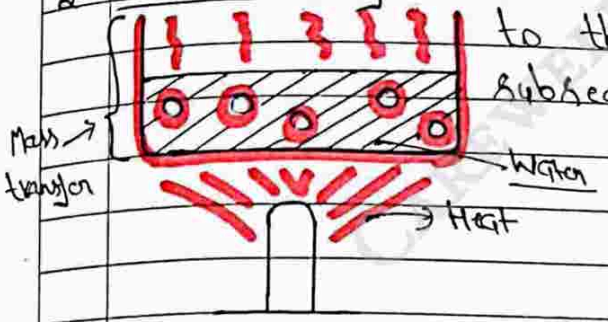
Ans→ It's the process of removing of small amount of liquid [water, moisture] by the application of heat to obtain dry solid. is called drying.

• Mechanism → It involves two process:
1→ Heat transfer.
2→ Mass transfer.

1. Heat transfer → In this, heat is generated within the solid and flow to the exterior surface.



2. Mass transfer → It involves movement of the moisture to the surface of the solid and its subsequent evaporation from the surface.

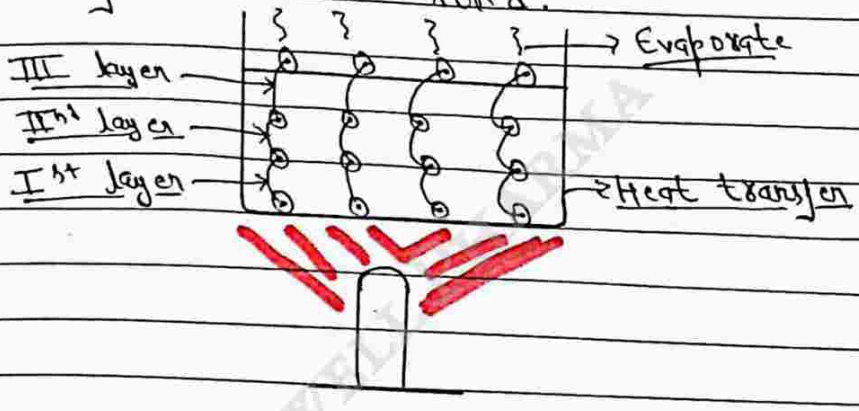


- Theories → There are also two theories of drying:

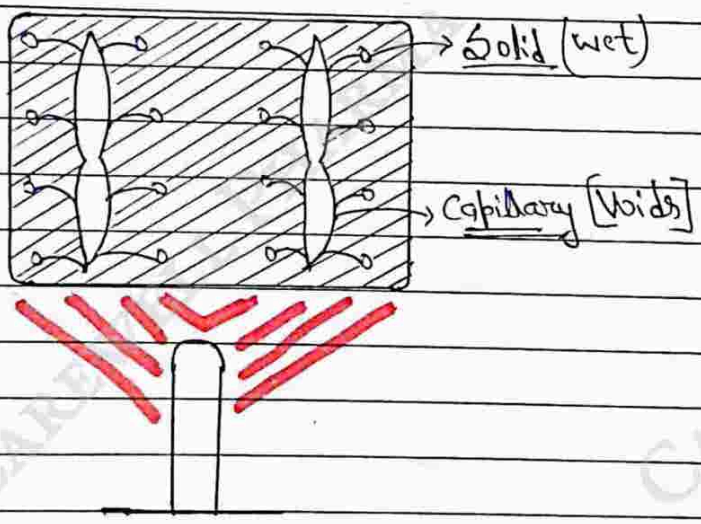
1. Diffusion theory.
2. Capillary theory.

1. Diffusion theory → According the diffusion law, heat transfer from high conc. to low conc.
So, when heat apply on the wet solid, the bottom particles of the liquid get heated, then they transfer their heat to another one [Ist layer], then it transfer to next [IInd layer] and the last final particle of liquid [on the top] get evaporated.

→ And finally dry solid obtained, all water [liquid] remove from wet solid.



2→ Capillary theory → Their are some capillary like voids present in wet solid. So, when we provide heat on that solid, liquid [water] get removed through that voids.
→ And we get dry solid.

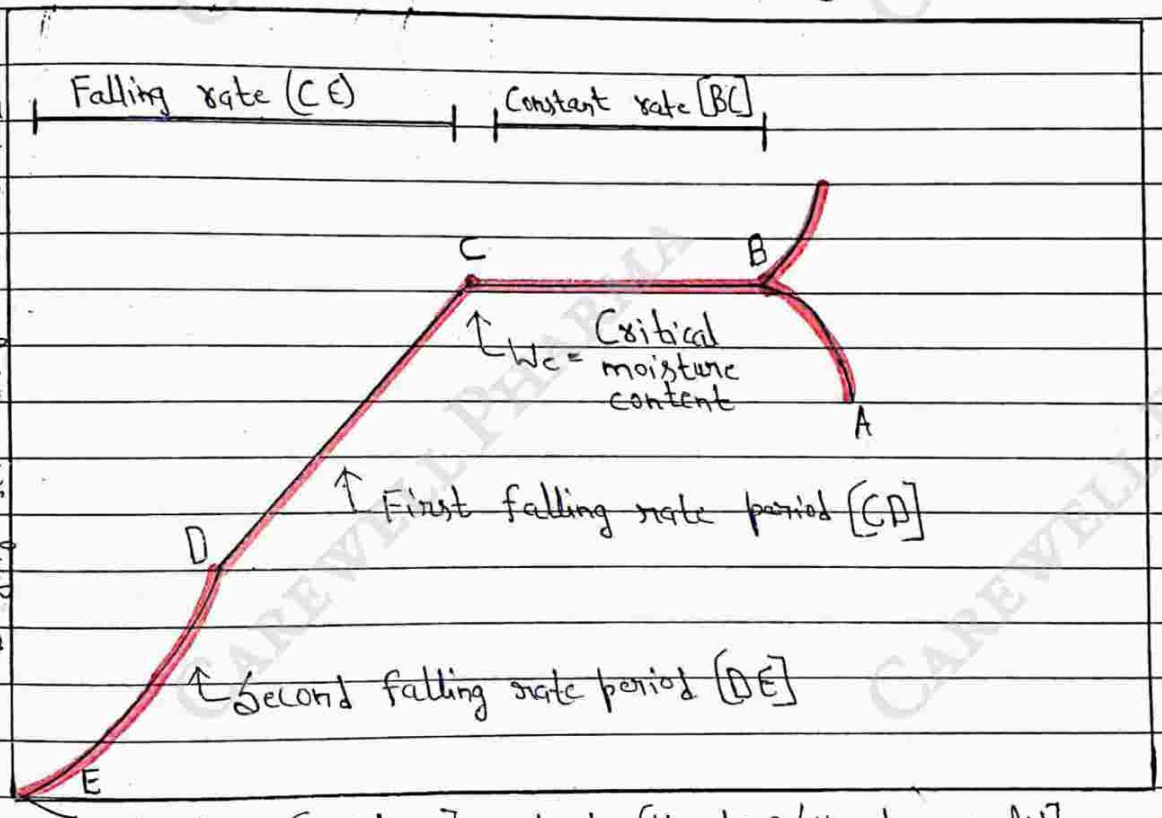


Q-2- Write a short note on Rate of Drying Curve?

Ans:- It follow two drying zones :
1- Constant - rate - period.
2- Falling - rate - period.

① Constant rate period → The moisture vapourised per unit time per unit area of drying surface remains constant.

② Falling rate period → The amount of moisture vapourised per unit time per unit area of drying surface decreased continously.



- **Critical Moisture Content [CMC]:**

It is a break point of two zones, where the moisture content at which the constant rate drying period ends and the falling rate drying period start.

- **Point B** → It represent equilibrium temperature condition of the product surface.
- **Curve BC [constant rate]** → It represents removal of the unbound water from the product.
- **Curve CD [first falling rate]** → It occurs when wetted spots in the surface continually decline until the surface is dried.
- **Curve DE [second falling rate]** → It begins at point D and the ends at point E, when the surface is ~~com~~ completely dry.
- **Point C** → It represents decrease in drying rate start is referred to as the critical moisture content [CMC].

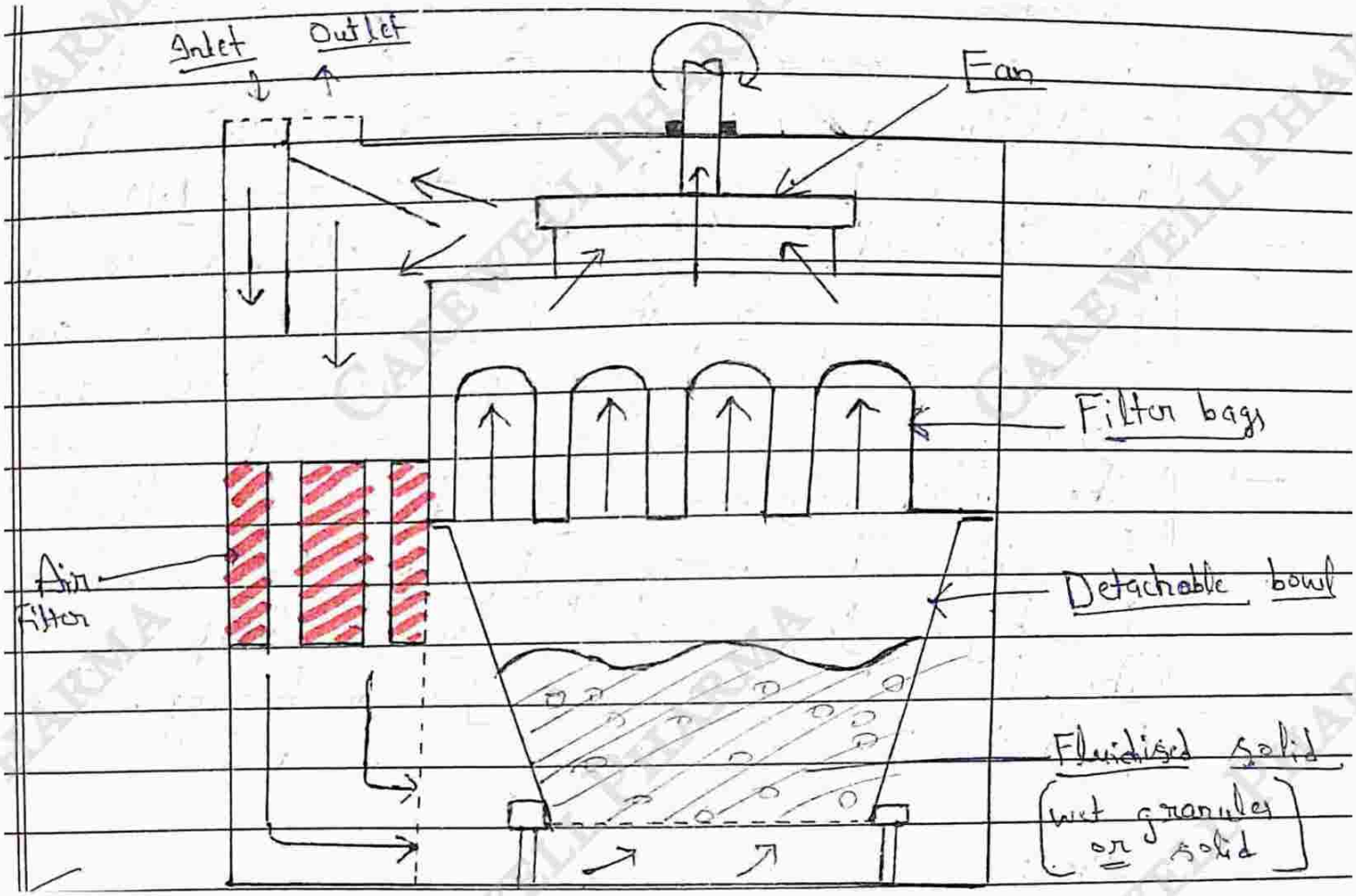
Q3. Describe in details about :

Ans:- Fluidised bed dryer :

- Principle → In this dryer, hot air is passed at high pressure through a perforated bottom of the container granules to be dried. The granules are lifted from the bottom and the suspended in the ~~stat~~ steam of the air, this condition is called Fluidised State. The hot aim is surrounding every granules for the completely dry them. Thus, material or granules are uniformly dried.

- Construction :

→ It is made up of stainless steel.
→ A detachable bowl is place at the bottom of the dryer, it is used for load material.
→ A fan is mounted in the upper part of dryer for circulating hot air.
→ Fresh air inlet & heat Exchanger are connected serially to heat the air to the require temperature.
→ Bag filter are placed above the detachable bowl for the Recovery of fines.



- Working:

→ The wet material to be dried are placed in the detachable bowl.
→ Fresh air is allowed to pass through a prefilter, which subsequently get heated by passing through a heat exchanger.
→ The hot air flow through the bottom of the bowl, simultaneously fan is allowed to the rotate.
→ The air velocity is a gradually ~~in~~ increased.
→ When the velocity of the air is greater than settling velocity of the granules, the granules remain partially suspended in the gas stream.
→ After sometimes, granules rise in the container because of high velocity, later fall back in the random boiling motion.
→ The gas surrounds every granules to completely dry them, the air leaves the dryer by passing through the bag filter.
→ The entrained particles remain adhered to the inside surface of the bags, the bags are shaken of the bags, the bags are shaken to remove the entrained particles.
→ The residue of the time for drying is about 40 mints. The material is left for sometime in the dryer for reading ambient temperature.
The bowl is taken out for discharging. The end product is free flowing.

• Uses:

→ It's used for drying of granules in the production of tablets.
→ It can be used for three operation: mixing, granulation & drying.

• Advantages:

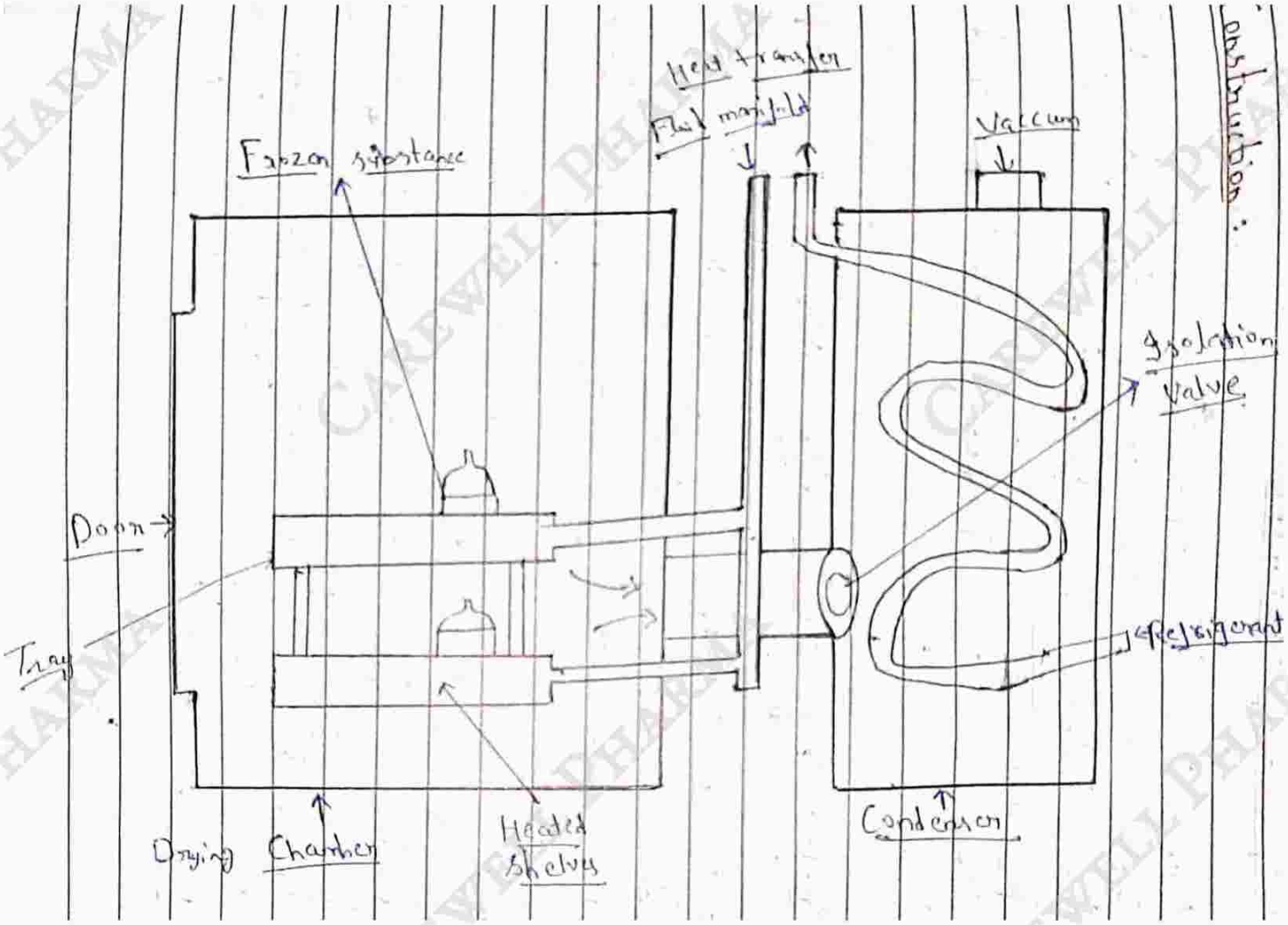
→ It requires less time to complete drying.
→ It is available in different sizes with drying capacity from 5 to 200 kg per 1 hour.
→ It also used in mixing.

• Disadvantages:

→ Many organic powders develop electrostatic charges during drying. To avoid this, efficient electrical earthing of the dryer is essential.
→ May cause some attrition, resulting in the production of fines.

2→ Freeze Dryer: It is also known as lyophilization.

• Principle → In this dryer, water is removed from the frozen state by sublimation, i.e., direct change of water from solid into vapours without conversion to a liquid phase.



• Construction :

→ It consist of drying chamber in which tray are loaded the materials.
→ Heat supply in the form of the radiation.
→ Vapour condensing or adsorption system.
→ Vacuum pump or steam ejector are both.

• Working → It involves five stages :
1) Preparation and pre-treatment.
2) Pre-freezing to sodify water.
3) Primary drying.
4) Secondary drying.
5) Packing.

1) Preparation & pre-treatment → It is a essential process, in which reduces the actual drying by 8 to 10 times.
→ The solution is pre-concentrated under normal tray drying, the final-product becomes more porous.
→ Liquid or solid desiccants are also used for this.

2) Pre-freezing to sodify water → In this, Vials and ampoules or bottles in which the solution is packed are frozen in cold shelves [about 50°C]. During this stages, Cabinet is maintaind at low temp. and atmospheric pressure.

3) → Primary drying → In this, the material to be dried is spread as much large surface as possible for sublimation. The temp. and pressure should be below the triple point of the water, i.e., 0.0098°C & 0.533 Kilo pascals [4.58 mm Hg] for the sublimation.

→ Vacuum is applied to the tune of about 3mm Hg on the frozen sample. The temp. is linearly increase to about 30°C in a span of two hours.

→ All the things has to be controlled in such a manner so as to get highest possible water vapour at ice surface without melting the material.

→ Primary drying stages removes easily removable moisture [98% to 99% water is removed].

4) → Secondary drying → In this stage, traces of moisture is removed.

→ The rate of drying is very low and it takes about 10 to 20 hours.

5) → Packing → After vacuum is replaced by inert gas, the bottles and vials and closed.

• Uses → It is most commonly used in the production of dosage forms such as injections, solutions and suspensions.

- Advantages :

→ It is thermolabile material [heat sensitive] can be dried.
→ Loss of volatile materials is less.
→ Sterility can be maintained.

- Disadvantages :

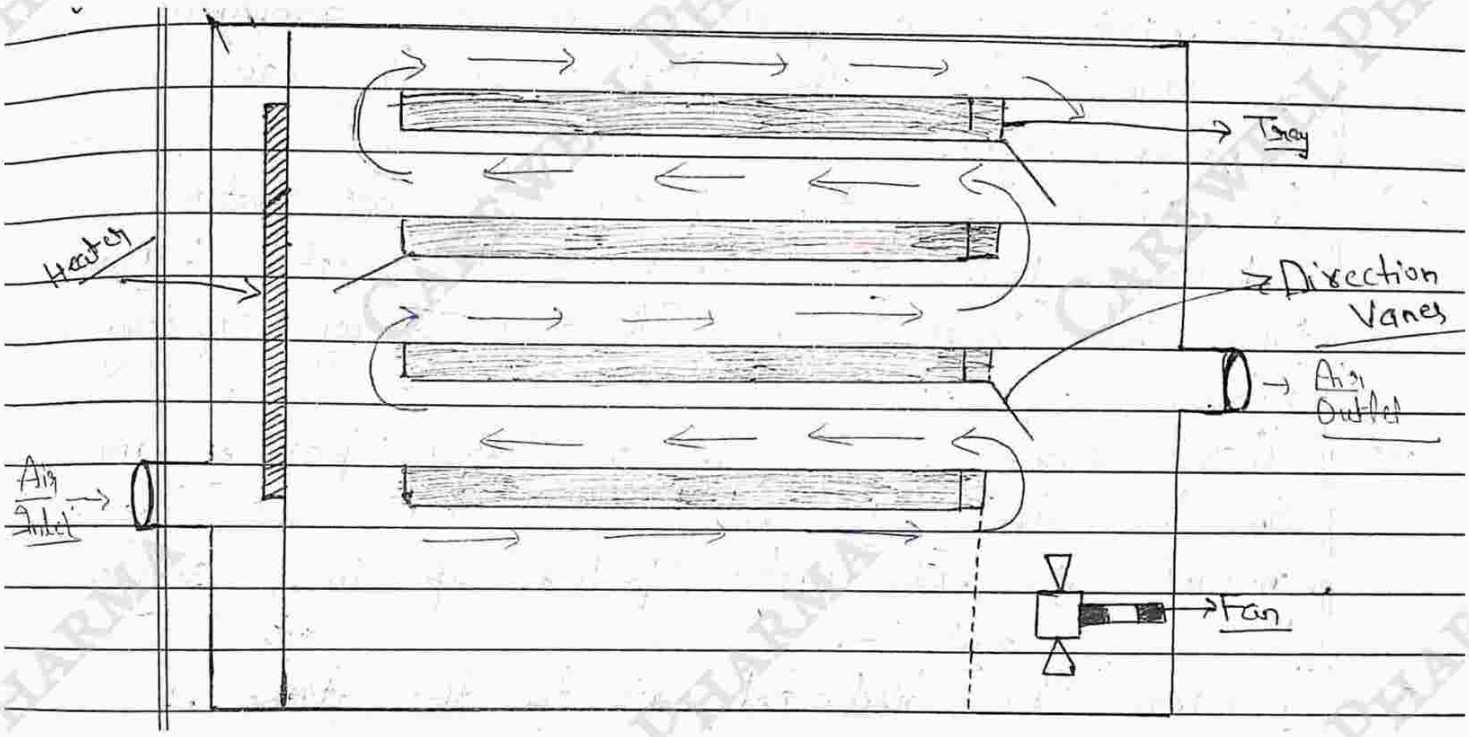
→ Equipment and running costs are high.
→ The period of drying is high.

3→ Tray Dryer :

- Principle → In this dryer, hot air is continuously circulated forced convection heating takes place to remove the moisture from the solids placed in the trays. Simultaneously, the moist air is removed partially.

- Construction :

→ It consists of rectangular chamber whose walls are insulated.
→ Trays are placed inside the heating chamber.
→ The number of tray vary [change] with the size of the dryer.
→ Dryer is fitted with a fan for circulating air over the trays.



→ These are also some direction vanes are placed in the corner of the chamber to direct air in expected path.

• Working :

→ Firstly wet solid is loaded into trays, then trays are placed in the chamber.
→ Now, fresh air is introduced through inlet, which passes through the heaters and get heated up.
→ The hot air is circulated by means of fans at 2 to 5 seconds. Turbulent flow lowers the partial vapour pressure in the atmosphere and also reduce the thickness of the air boundary layer.
→ The water is picked up by the air, as water evaporates from the surface, the water diffuses from the interior of the solid by capillary action.
→ These event occurs in a single pass of the air, so the time of contact is short and the amount of water picked up in a single pass is small.
→ Therefore, the discharge air to the tune of 80 to 90% is circulated back through fans, only 10 to 20% of fresh air is introduced.
→ Moist air is discharge through outlet.
→ Thus, constant temp. & uniform airflow over the material can be maintained for achieving uniform drying.

→ At the end of drying, trays are pulled out of the chamber and taking to a tray dumping station.

[In case of wet granules drying is continued until the desired moisture content is obtained]

∴ Uses :

→ It is use for sticky material, plastic substances, granules, salts, precipitates and ~~plastics~~ pastes can be dried in a tray dryer.

• Advantages :

→ Handling of material can be done without losses.
→ It is operated batch-wise.
→ Valuable product can be handled efficiently.

• Disadvantages :

→ Tray dryer requires more labour to load and unload. Hence, cost increased.
→ Process is time consuming.

Q-1: Describe in details about factors affecting mixing process?

Ans: There are some factors which affect the mixing :

1:- Nature of the product.
2:- Particle size.
3:- Particle shape.
4:- Particle charge.
5:- Density.

1):- Nature of product → The nature of the product are same then the rate of mixing is increased.

Same Nature ∝ Mixing ↑ised

2):- Particle Size → The particle size are more small then the rate of the mixing is increased.

Particle size ↓ised ∝ Mixind ↑ised.

3):- Particle shape → The particle shape are same then the rate of the mixing is increased.

Same Particle Shape ∝ Mixing ↑ised.

→ Irregular shape particles mixing is decreased and the rate of mixing and also non-uniformly.

4):- Particle Charge → A different charge particles mixing may be decrease the mixing, because positive and negative charge not attract each other and not attached.
So, neutral charge particles mixing increased the rate of mixing.

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Particle charge are neutral the rate of mixing is increased.

Neutral charge particles ∝ Mixing ↑ised.

5)→ **Density** → The density are more then the rate of the mixing is ~~increased~~ decreased.

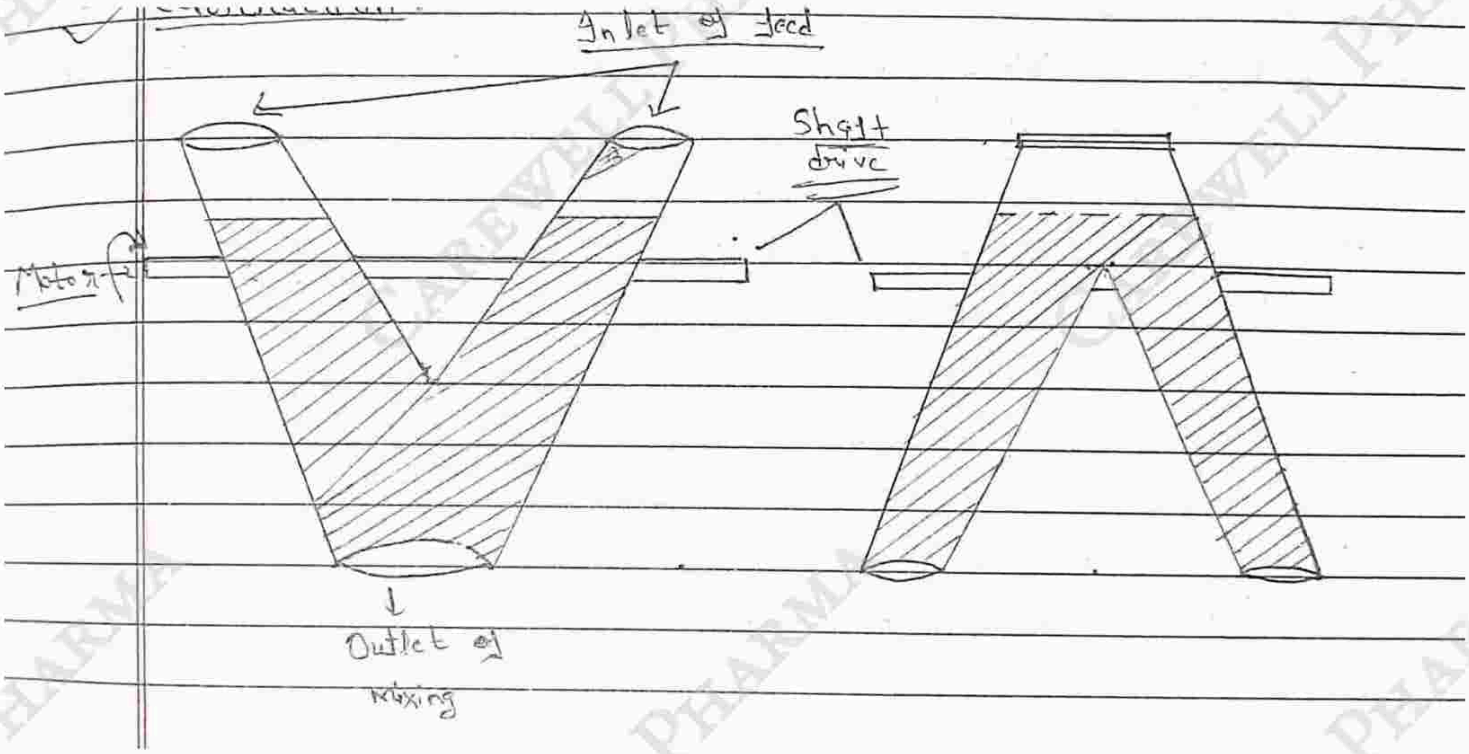
Density are more ∝ Mixing ↓ised.

Q-5→ Explain in details about :

Ans→ **Twin Shell** → It is also known as V-Cone Blender.

- **Principle** → The mixing occurs due to the tumbling motion
- **Construction**:

→ It is made up of stainless steel or transparent plastic.
→ Smaller models ~~like~~ a take a charge of 20 kg and rotates at 35 round per mint. While large one has capacity about 1 ton and 15 round per mint.
→ It is connected with horizontal shaft drive, which is connect with the motor for rotation.



- Working:

→ The material is loaded into the blender approx 50% to 60% of its total volume.
→ As the blender rotates, the material undergoes tumbling motion.
→ When the V is inverted, then the material is split and recombine, this process yield or obtain to the mixing.
→ After mixing, mixed the material is collected in the bottom of V.
→ Blender speed is need to maintain for prevent shear.

- Uses:

→ It is used for solid mixing.
→ It is used mixing of order.

- Advantages:

→ They are handle large capacity.
→ It is easy to clean, load & unload.
→ Requires minimum maintainance.

- Disadvantages → It is not suitable for ingredient of large differences in the particles size distribution.
→ Not enough size.
→ Require high headspace for installation.

Double Cone Blender

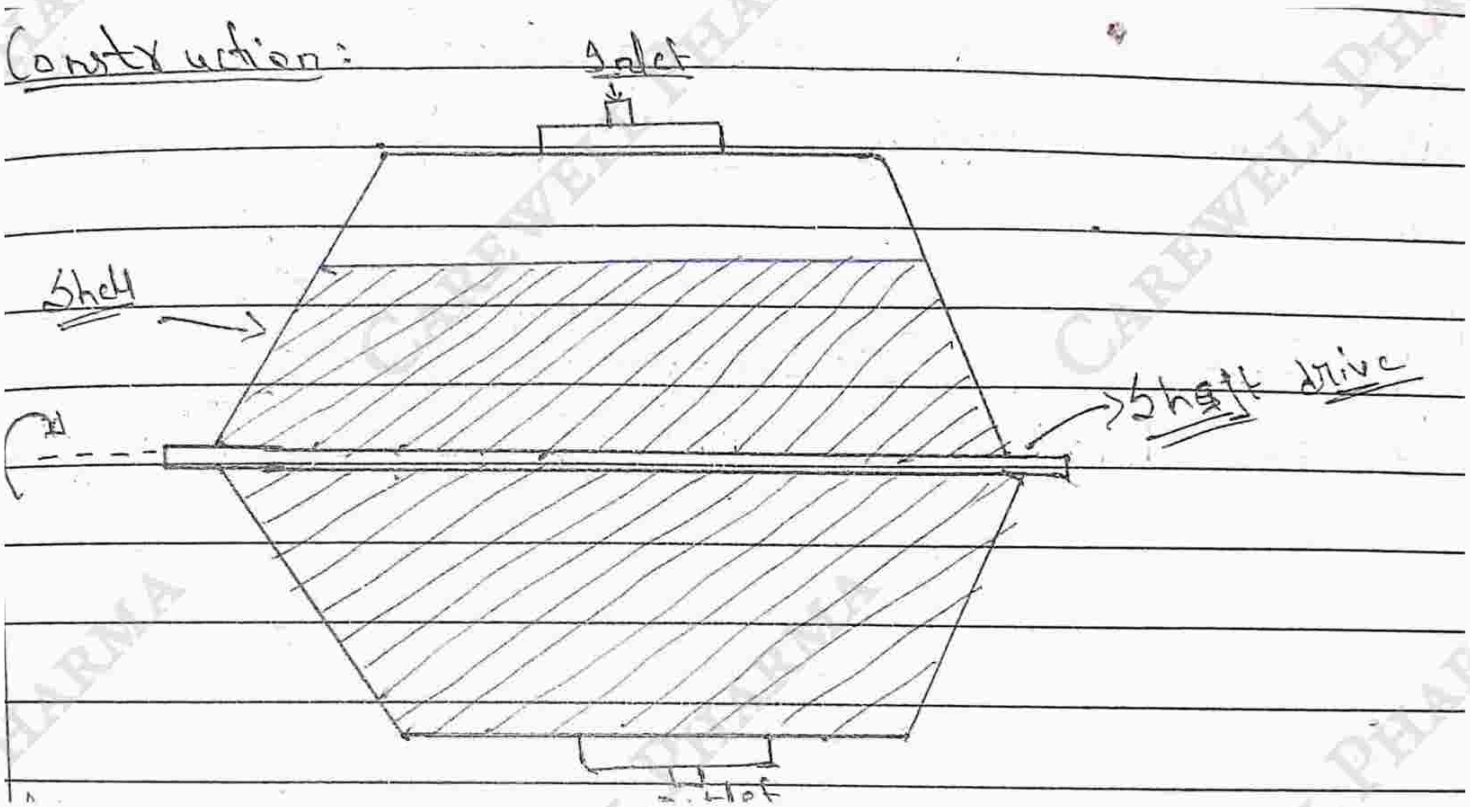
- **Principle** → The mixing occurs due to the tumbling motion.
- **Construction:**

→ It is made up of all part of equipment ~~are~~ with stainless steel.
→ It consist of two cones, which are attached and rotated.
→ One horizontal shaft drive which are attached with motor for rotation.

- **Working:**

→ The material is filled upto 50 to 70% of its total volume.
→ Generate rate of rotation is about 30 round per mint, otherwise it depends on the blender's size.
→ When blender rotates, it create tumbling motion, due to this mixing occurs.
→ It is an efficient design for mixing powders of different densities.
→ It is usually charged and discharged through the same part.

Construction:



- Uses:

→ It can be used for pharmaceuticals preparation, powders.
→ Homogenous mixing of the dry powders and granules.

- Advantages:

→ They handle large capacities.
→ Easy to clean, load and unload.
→ Requires minimum maintaince.

- Disadvantages:

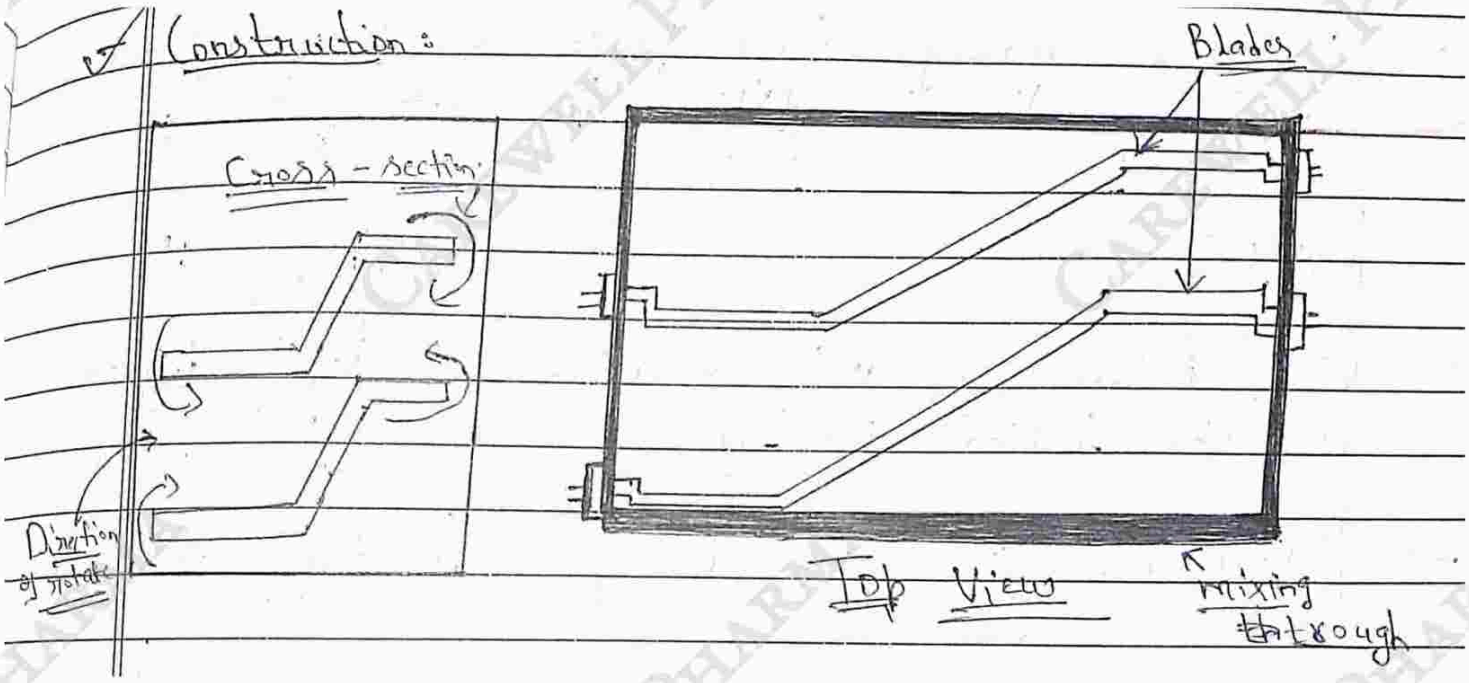
→ It is not suitable for ingredients of the large differences in the particles size distibution.
→ It is not enough size.
→ Require high headspace for installation.

2. Sigma Blade Mixer:

- Principle → The mixing occurs due to the shear, and also convective mixing is achieved by the cascading the material.

- Construction:

→ It consist of double through/follicle/dip shaped stationary bowl.



→ Two Sigma Shaped blades are fitted horizontally in each trough of the bowl.
→ They are connected to a Shaft drive with a fixed speed.
→ The mixer is loaded from the top and unloaded by tilting the entire bowl.

• Working :

→ Material are introduced from the top of the trough and then covered it.
→ Now, allowed the Sigma blades to rotates through the fixed Speed drive.
→ The blades move at different Speeds, one usually about twice the Speed of the other, resulting in the lateral pulling of the material.
→ By moving the material through blades, cascading action as well as the shear action can be achieved.
→ By this, mixing take place and final mixture discharge through tilting the entire bowl.

• Uses :

→ It is used for Solid-liquid mixing and mostly used in Solid-Solid mixing.
→ It is commonly used for mixing of dough ingredient in the baking industries.

• Advantages:

→ It has minimum dead spot during mixing.
→ It has close tolerance b/w the blades and the side-walls as well as bottom of the mixer shell.

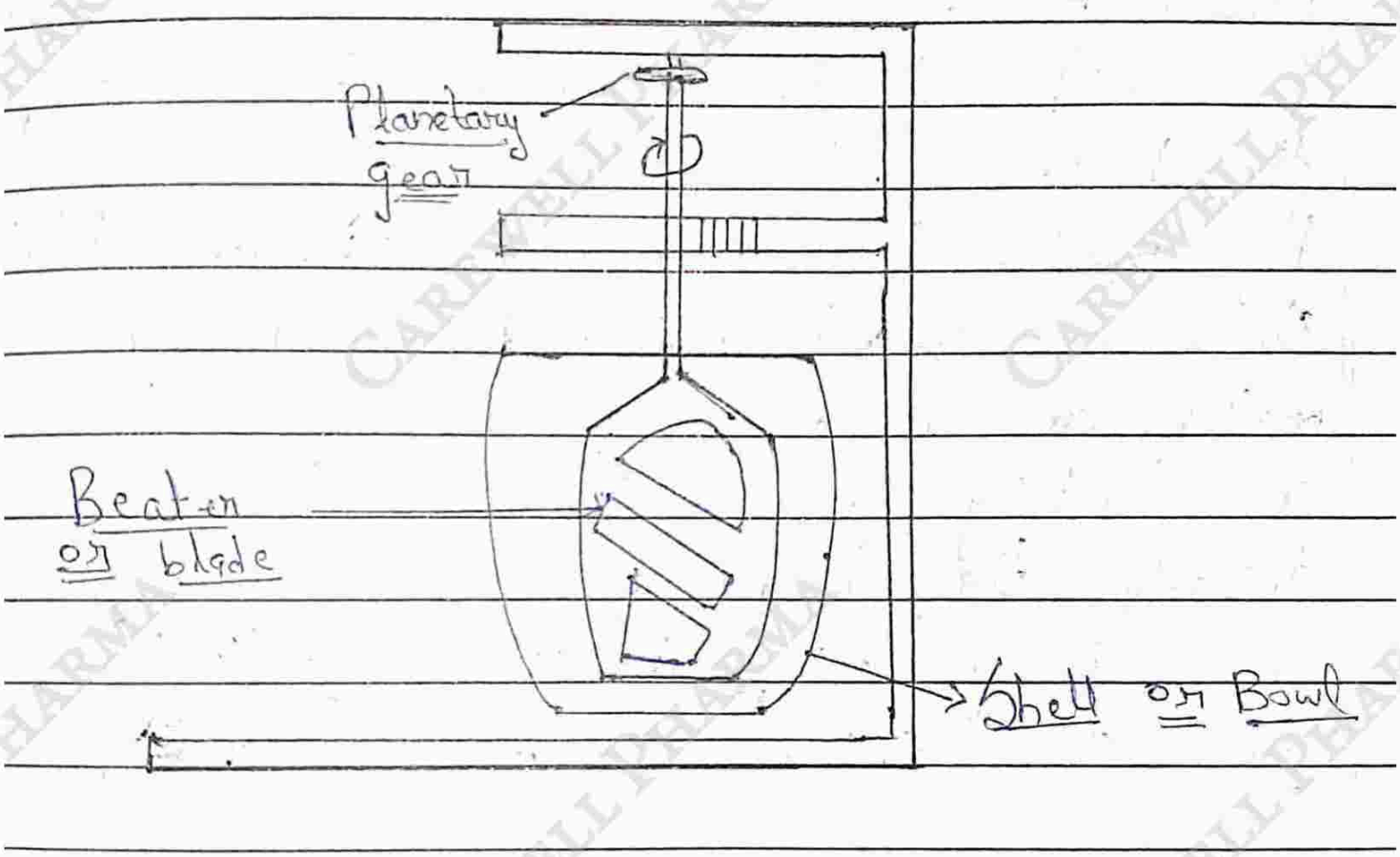
• Disadvantages :→ Sigma blades mixer works at a fixed speed.

3) Planetary Mixer:

• Principle →In this mixer, the blade tears the mass apart and shear is applied between a moving blade and a stationary wall.
→ It is a mechanism of mixing is shear & also tumbling motion obtain.

• Construction:

→ It consist of a vertical cylindrical shell, which can be removed either by lowering it beneath / falling the blade or raising the blade above the bowl.
→ Mixing blade is mounted from the top of the bowl.
→ The mixing shaft is driven by a planetary gear train.
→ It rotates around the ring gear, which further rotates round the mixer blade.
→ It is normally built with a variable speed drive.



- Working:

→ In the planetary mixer, the agitator has a planetary motion.
→ It rotates on its own and around the central axies, so that it reaches all part of the vessels.
→ Beater is shaped to pass with close clearance over the side and bottom of the mixing bowl [no dead ~~spot~~ space in the mixing bowl].
→ Material is introduced through the top of the bowl
→ By moving material and also make powder an upward movement.
→ So, tumbling motion is also obtained.
→ Initially the blade moves slowly for premixing and finally at increased speed for active mixing. [high shear can be applied for mixing].

→ Emptying the bowl may be done by the hand [scooping] or by dumping mechanism.

- Uses:

→ Low speed are used for dry mixing.
→ Fast speed in wet granulation.
→ Steam jacketed bowls are used in the manufacture of ~~fats~~ sustained release product and ointments.

- Advantages :

→ Speed of the rotation can be varied as needed.
→ More useful for wet granulation.
→ No dead spot (unmixing space).

- Disadvantages :

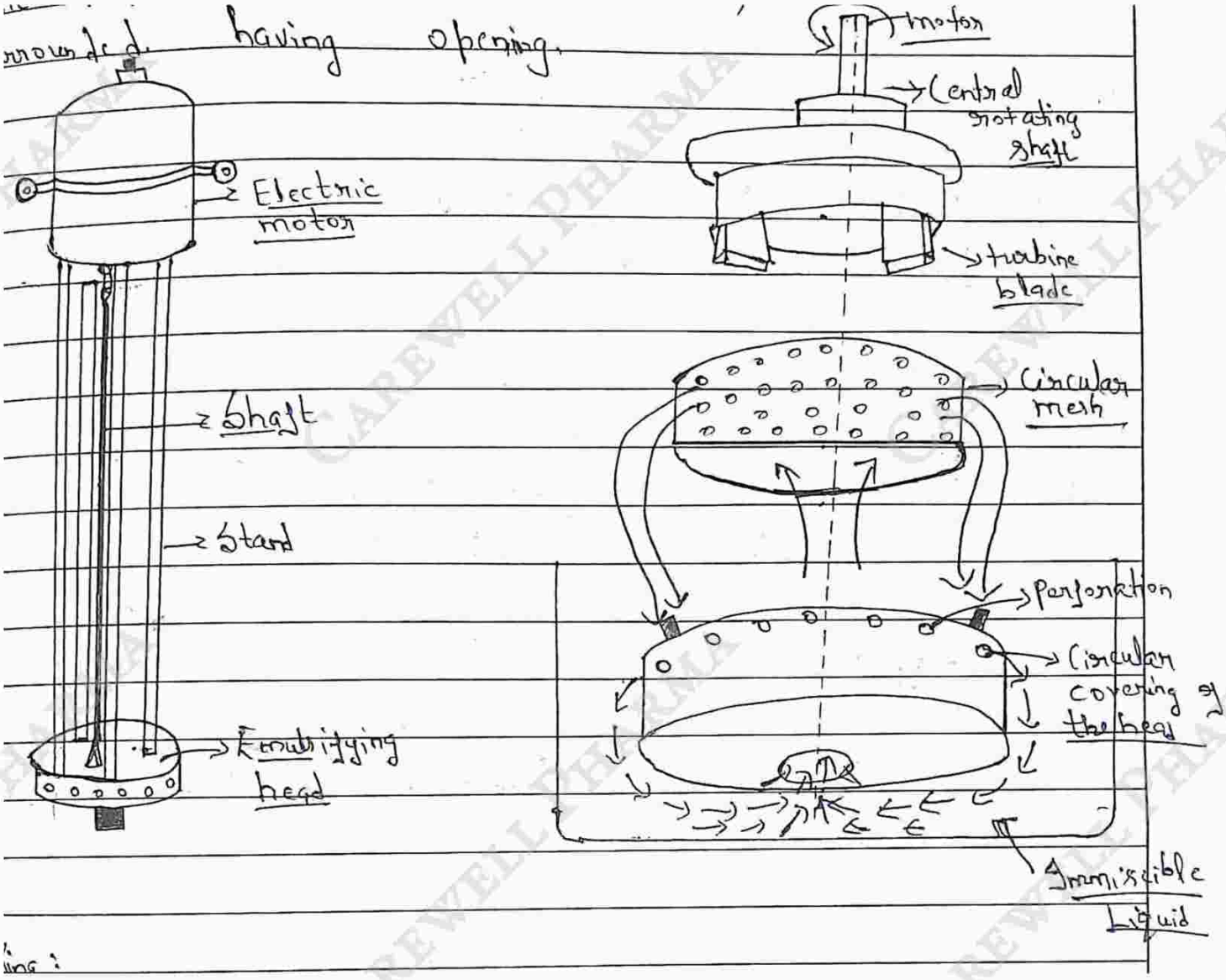
→ It requires high power.
→ It has limited size and it is useful for batch wish only.

4) → Silverson - Mixer - Emulsifier :

- Principle → It produce intense shearing force and the turbulence by the use of the high-speed rotors.

- Construction :

→ It consists of long supporting columns connected to a motor which gives support to the head.
→ The central portion contain a shaft, one end of which is connected to the motor & other end of which is connected to the head.
→ The head carries turbine blades, which are surrounded having opening.



- Working :-

→ The head is placed in the vessels containing immiscible liquid it is fully dipped in a liquid.
→ Then, start a motor, rotating shaft rotates the head, which in turn rotates turbine blades at a very high speed.
→ This creates a pressure difference. As a result, liquids are sucked into the head from the center of the base and subjected to intense mixing action.
→ Then liquid is expel from the mesh through centrifugal forces.
→ The intake and expulsion of the mixture ensure the rapid breakdown of the ~~par~~ particles and help to the mix them.

- Uses → It's used for the preparations of emulsion & creams of the fine ~~powder~~ particles etc.

- Advantages → It's available in different size.
→ It can be used for batch wish.

- Disadvantages → Sometimes, this is a chances of blocking of ~~the~~ pores of the mesh.

Page No.:

Unit - 4

Q-1:- Write a note on theories of filtration?

Ans:- In filtration, the flow of liquid follow basic rules that govern the flow of any liquid through the medium offering resistance.

$$\text{Rate of filtration} = \frac{\text{Driving force}}{\text{Resistance}}$$

→ Driving force, is the pressure differential b/w the upstream and downstream of the filter.
→ Resistance, which resist the filtration.

• In this, there are 3 types of ~~theories~~ equation of filtration:
1:- Poiseuille Equation.
2:- Darcy Equation.
3:- Kozeny Carman Equation.

1):- Poiseuille's equation → Poiseuille considered that the filtration is similar to the streamline flow of a liquid under pressure through a capillaries.

$$V = \frac{\pi \Delta P r^4}{8 L \eta}$$

Where, V → Rate of flow.
π → Constant 3.1.
ΔP → Pressure difference across the filter.
r^4 → Radius of the capillary in the filter cake.
8 → Constant.
L → Length of the capillaries.
η → Viscosity of the filtrate.

2) → Darcy's Equation → The factor influencing rate of the filtration has been incorporated into an equation.

$$V = \frac{KA\Delta P}{\eta L}$$

Where,
V → Rate of flow.
K → Permeability coefficient of cake.
A → Surface area of filter medium.
ΔP → Pressure difference across the filter.
η → Viscosity of the filtrate.
L → Length of the capillary.

3)→ Kozeny Carman Equation → This equation is the resultant equations of Poiseuille and Darcy, which is widely used in filtration.

$$V = \frac{A}{S^2} \cdot \frac{\Delta P}{KL} \cdot \frac{\varepsilon^3}{(1-\varepsilon)^2}$$

Where,
V → Rate of flow.
A → Surface area of the filter medium.
S → Surface area of particles comprising the cake.
ΔP → Pressure difference across the filter.
K → Kozeny constant.
L → Length of the capillary.
ε → Porosity of the cake.

Q-2→ Write a note on factor affecting rate of filtration?

Ans → Factor Influencing/affecting filteration → They will be either decrease or they will be increase the filtration.
→ There are divided five types of this:
i) → Surface area, (iii) → Filter cake, (v) → Pressure difference.
ii) → Particle size, iv) → Viscosity,

(i) :- Surface area of filter media → In this, surface area of the filter media is directly proportional to the rate of filteration.

→ Surface area are increased then the rate of filtration is also increased.

S.A. ∝ Filtration ↑ or S.A. ↑ = Filtration ↑

(ii) :- Particle size of solids → In this, particle size is directly proportional to the rate of filtration.

→ Particle size of solid are increased then the rate of filtration is also increased.

P.S. ∝ Filtration ↑ or P.S. ↑ = Filtration ↑

(iii) :- Filter cake [resistance] → In this, filter cake is inversly proportional to the rate of filteration.

→ Filter cake is increased then the rate of filtration is decreased.

$F.C. \propto \frac{1}{\text{Filtration}}$ or F.C. ↑ = Filtration ↓

(iv) :- Viscosity → In this, viscosity is inversly proportional to the rate of filtration.

→ Viscosity are increased then rate of filtration is decreased.

Viscosity $\propto \frac{1}{\text{Filtration}}$	or	Viscosity ↑ = Filtration ↓

(v) :- Pressure difference → In this, pressure difference is directly proportional to the rate of filtration.

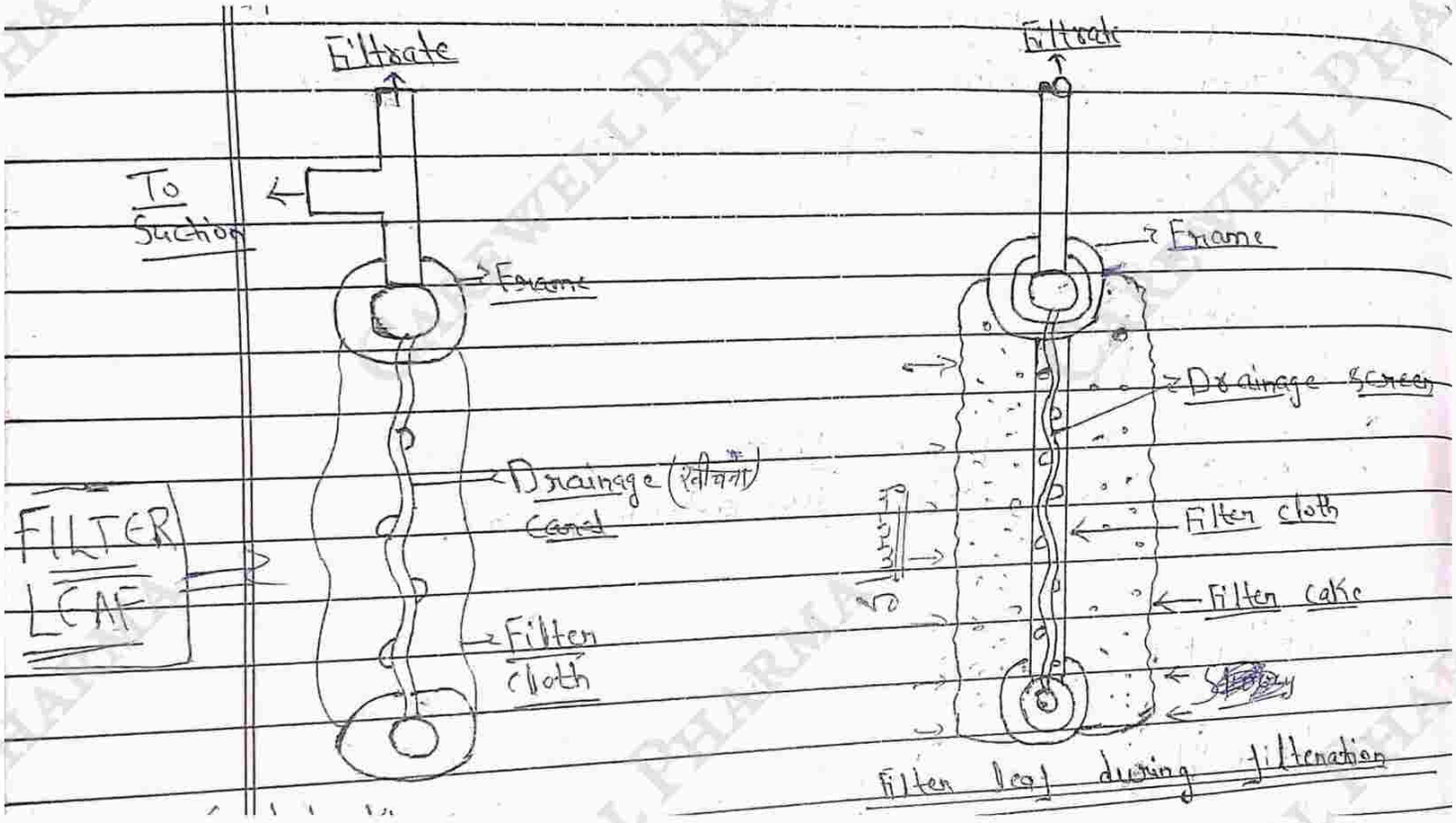
→ Pressure difference are increased then rate of filtration is also increased.

$\Delta H \propto$ Filtration	or	ΔH ↑ = Filtration ↑

Q-3:- Write down the principle, construction, working, uses about filter leaf ?

Ans :- Principle → It is an apparatus consisting of a longitudinal drainage screen covered with a filter cloth.

The mechanism is surface filtration and acts as a seive. Vacuum or pressure can be applied for increased the rate of filteration.



- **Construction:**

→ It consist of narrow frame enclosing a drainage ~~sect~~ screen.
→ The frame may be of any shape i.e., square, circular & rectangular.
→ The whole unit is covered with the filter leaf.
→ The outlet for the filtrate connects to the interior of the frame through to suction.

- **Working:**

→ The filter leaf is immersed in a slurry.
→ Vacuum system is connected to the filtrate outlet.
→ The slurry passes through the filter cloth.
→ Finally filtrate enters the drainage canal and goes through the outlet into the receiver.
→ Air is passed to the flow in opposite direction which facilitates removal of cake.

- **Uses** → It is satisfactory, if the solid content is not too large it is about 5% i.e., dilute suspension.

- Advantages :

→ It's the simplest form of filter used for batch process.
→ It is efficiency of washing is high.

- Disadvantages :

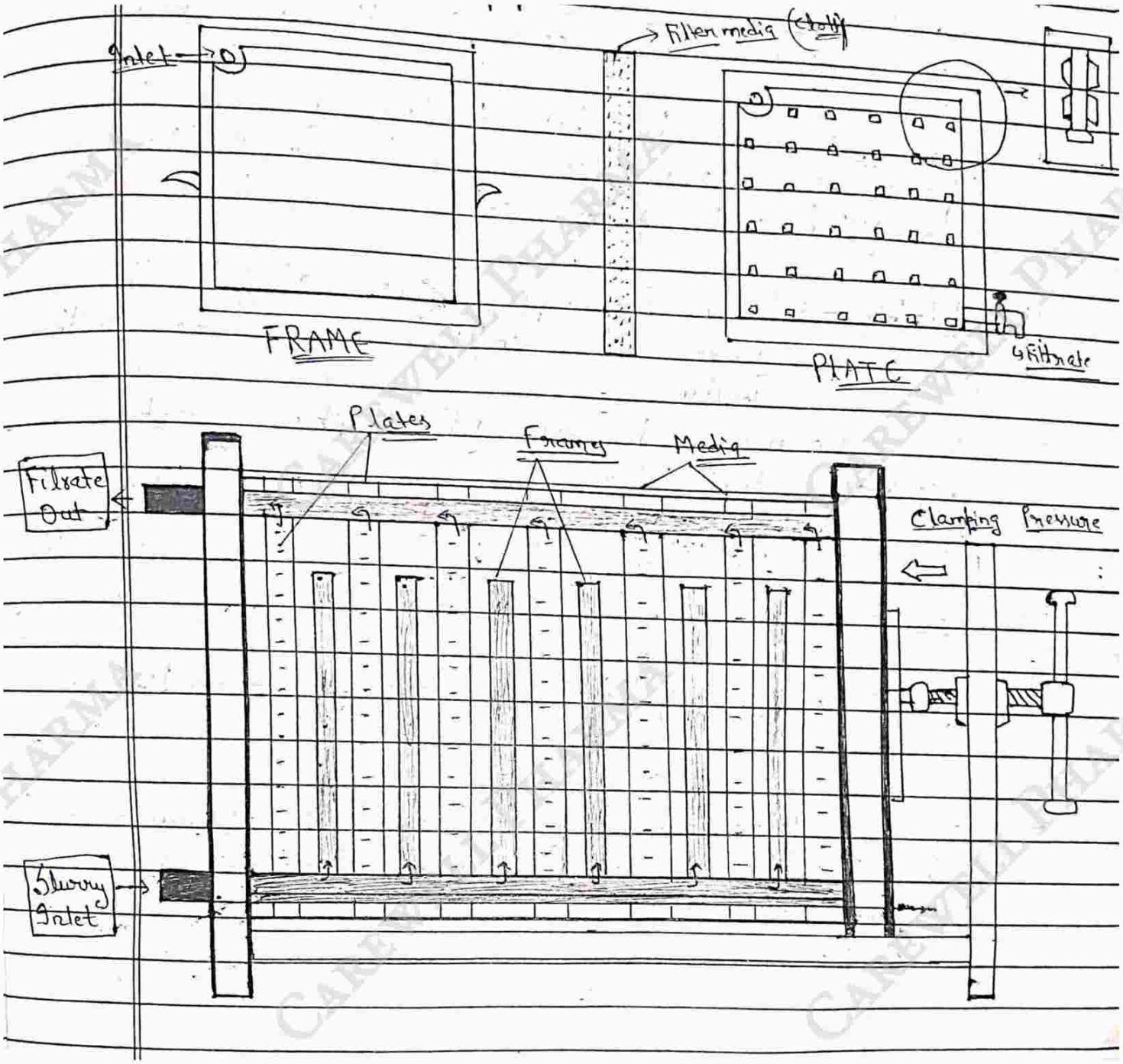
→ It is not suitable for large space/area.
→ Filter cloth life is relatively short.

Q.4→ Write in details about :

(i)→ Plate & frame filter : It is also known as filter Press.

- Principle → The mechanism is based on the surface filtration. The slurry enters the frame by pressure and flows through the filter cloth. The filtrate is collected on the plates and sent to the outlet.

- Construction → It consist of plates and frames.
→ The frame is open and is used as an inlet for the material to be filtered.



- Plate has groove support to the filter cloth.
- The plates and frames may be made of various metals which provide resistance to corrosion or prevent metallic contamination of the filtrate. [usually made up of alluminium alloy].
- Filter cloth is fitted on each side of the plate.
- The plates and frames are placed alternatively and fitted in the outer frames of the press.
- Each plate acts as a single filtration unit.
- The outlet of each plate is connected to a common outlet pipe.

• Working → It involves two steps:

1. Filtration.
2. Washing.

1) Filtration → The slurry inlet through a common inlet pipe of the frames, which further passes through filter cloth and the filtrate [liquid] is collected in the plates from where it is collected through common outlet pipe.
- The cake is deposited on the frames, the process of filtration is continued until the frame is filled with the filter cake.

2) Washing → When the process is stopped, then the frames is emptied on washed with the water.

→ It is necessary because filter cake create a resistance for filtration.

→ After the washing, the cycle [filtration] is restarted.

- Uses :

→ Removal of precipitated protein from insulin liquors.

→ If use filter sheet of asbestos and cellulose, it is capable for the retaining bacteria.

- Advantages :

→ It provides large filtrating area.

→ Efficient washing of the cake is possible.

→ It's construction is simple and easy & variety of material can be used.

- Disadvantages :

→ It is an expensive filter.

→ It is batch filter [don't continous process].

(ii) → Rotary Drum Filter :

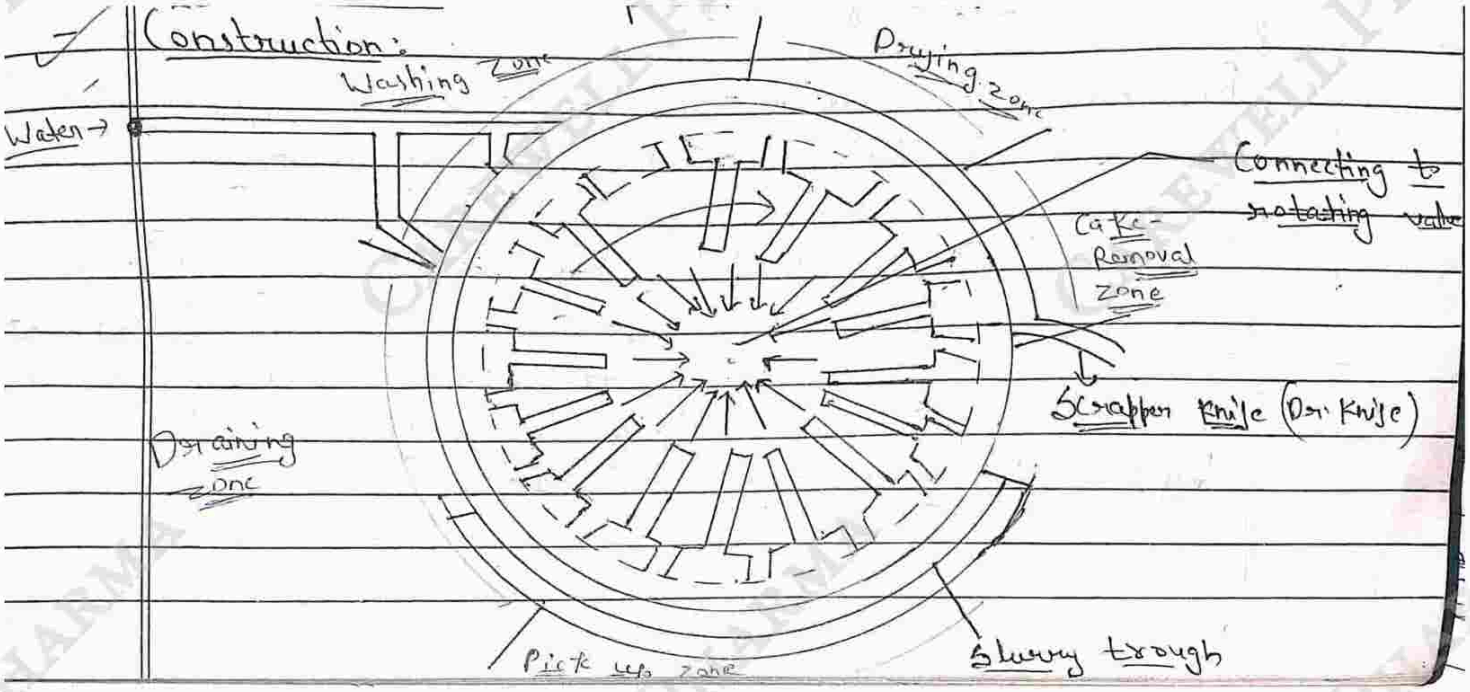
- Principle → It is based on the principle of filtering the slurry through a Sieve-like mechanism on a ~~drum~~ rotating drum surface, under the condition of vacuum.
- → In addition, compression, drying, and removing the filter cake is possible.

- Construction :

- → It consist of a metal cylinder mounted horizontally.
- → Drum have, diameter → 3 metres, length → 3.5 metres & surface area → 9 $metres^2$.
- → Filter cloth is used as filter media.
- → The drum is radially partioned dividing the ~~annular~~ annular space into separate compartments.
- → Each of it is connected by a internal pipe to the centre of the drum through a rotating valve.

Working :

- → The drum is dipped into the slurry. [Speed of drum is less than 1 rpm] & vacuum is applied to the outlet, which is connected to the filtrate. [Pick-up-zone].



- When the cake has formed, the cake drained ~~or~~ or partially dried by vacuum. [Drained - Zone].
- The drum is sprayed with water to wash the cake. [Washing - Zone].
- ~~Retait~~ Retaining the vacuum connection drains the cake and produces partial dryness. [Drying - Zone].
- Then cake is removed by doctor knife. [Cake removal zone.]
- A pre-coat of the filter aid is deposited on the drum of prevent blocking of filter cloth ~~t~~ during filtration process.
- ~~o~~

- **Uses:**

- It is used to filter slurries containing high proportion of solids. [5 to 30%].
- It is used in filtration of calcium carbonate, starch etc.

Advantages:

- Labour cost is low, due to it's automatic and continous process.

→ Filter has large surface area.
→ Cake is removed simultaneously.

• Disadvantages :

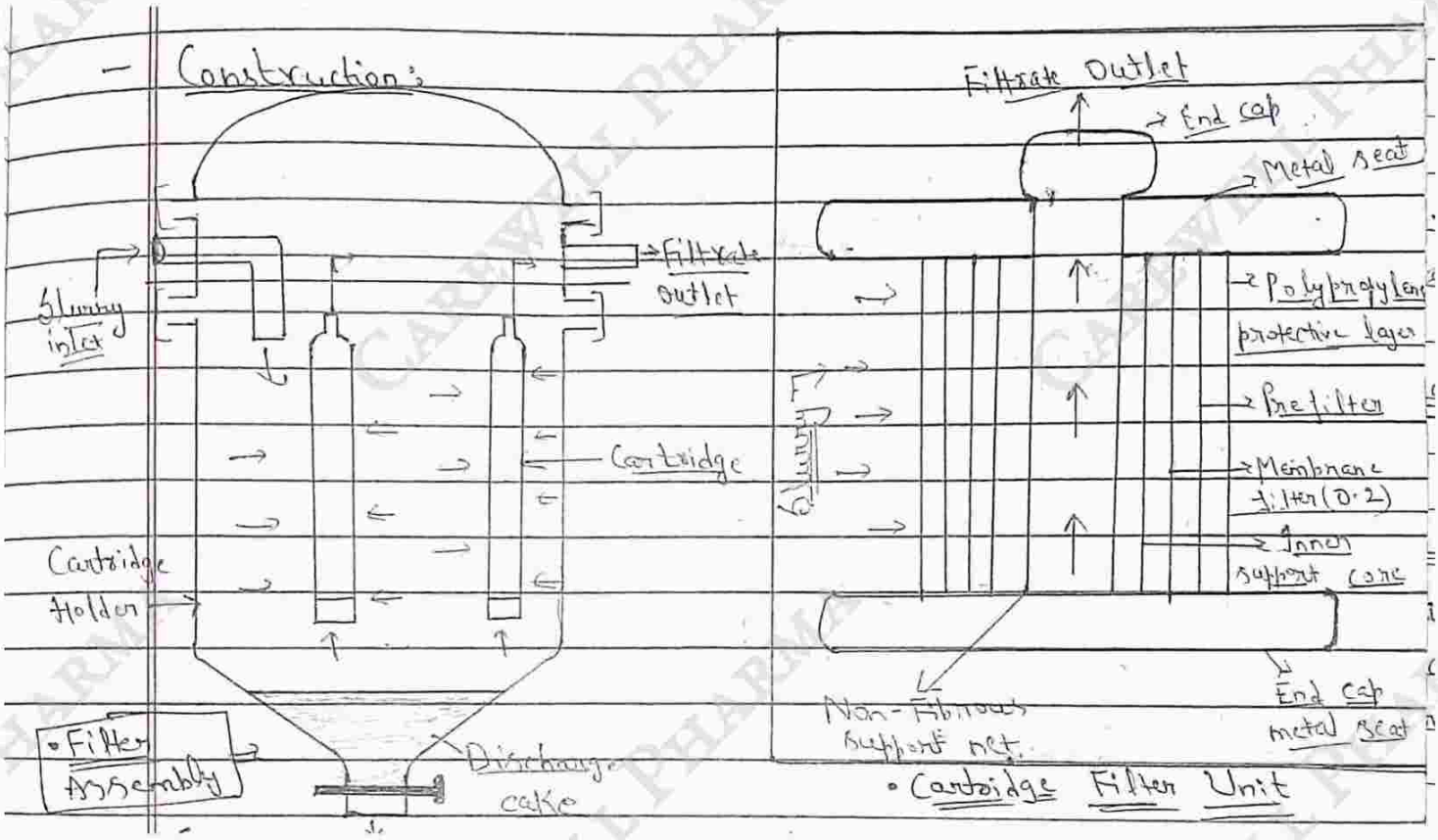
→ It is very expensive equipment.
→ Cake tends to crack.

iii) Cartridge Filter :

• Principle → It is a thin porous membrane in which the ~~the~~ pre-filter and membrane filter are combined into a 'single unit'.
→ The filtration action is mainly seive-like and the particles are retained on the surface.

• Construction :

→ It has cylindrical configuration with disposal or changeable filter media.
→ These are made up of plastic or metal.
→ It is made up of two membrane filter made of Polypropylene, a prefilter and an actual membrane filter with [0.2μm] housed in a holder.



- **Working:**

→ The slurry is pumped into the ~~cart~~ cartridge holder.
→ The passes through ~~cart~~ cartridge filter unit by the mechanism of staining.
→ The clean liquid passes to the centre and move upto collect through the outlet.

- **Uses:**

→ It used for preparation of particulate free solution for parental and ophthalamic uses.

- **Advantages:**

→ Stainless steel construction permits autoclaving for sterile operations.
→ It is rapid disassembling as well as reusing of filter media is possible.

- **Disadvantage** → It is expensive, due to cost of disposal elements.

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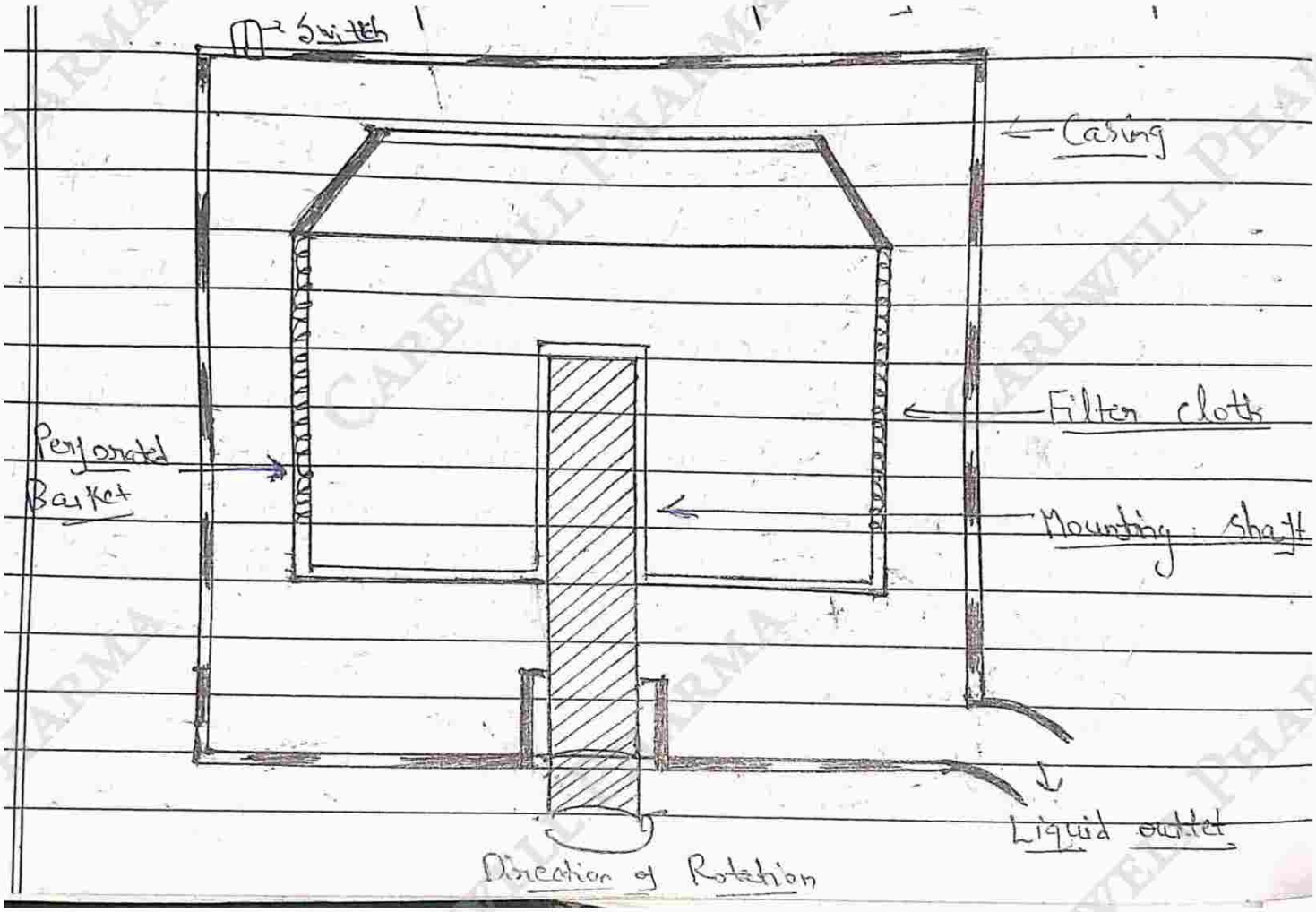
Q-5- Describe principle, construction, working and uses of Perforated Basket Centrifuge?

Ans= Perforated Basket Centrifuge:

- Principle → The separation occurs through perforated walls depend on the difference in the densities of the solids and liquid phases.

- Construction:

→ It consists of a basket made up of steal or any other suitable metal.
→ It is perforated with the filter cloth.
→ The basket is surrounded by the casing, which collect the filtrate and discharge through outlet.
→ The diameter of basket is 0.9 meter.
→ The diameter of perforation is depends on the crystal size.
→ The basket operated at speed of ~~to~~ about 1000 revolution per minute.



• Working :

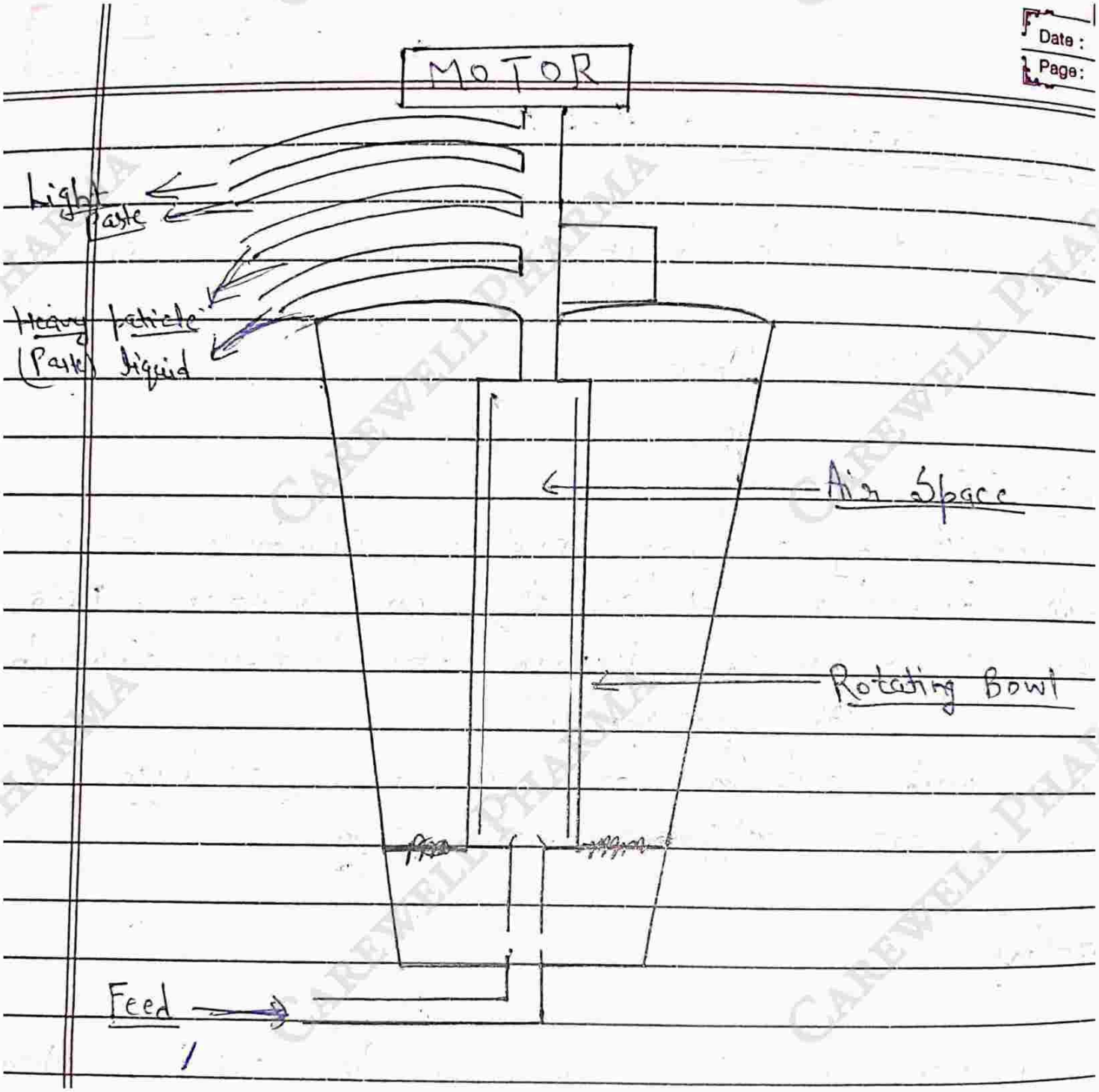
→ The material is loaded into the basket when it is an stationary.
→ Power is applied to rotate [5 Kw] then power is reduced to [2 Kw] speed 1000 rpm.
→ The liquid passes through perforated wall while the solid retains in the basket.
→ The liquid is collected through casing, centrifuge is stopped by applying brake.
→ Now unload the solid.

• Uses :

→ It used to separate crystalline drugs from the mother liquor.
→ It used to separate precipitated protein from the insulin.

Q-6 Describe principle, construction, working, uses, advantages & disadvantages of Supercentrifuge?

Ans → Principle → It is based on the sedimentation and it is used to separated two immiscible liquid phases depends on differences in densities.



• Construction:

→ It consist of a long, hollow, vertical bowl of small diameter and rotate on vertical axis.
→ Feed is introduced through the bottom of the bowl through a nozzle with pressure.
→ Two liquids outlets are provided at different height.
→ It rotates approx 2000 rpm.

• Working:

→ It rotates at 2000 rpm on its axis and then feed introduced through bottom nozzle with the pressure.
→ Two liquids phases were separated, according to their density, the heavier liquid moves towards the periphery and lighter liquid forms an inner layer.
→ Both liquids ascend to the upper part of bowl.
→ These removed separately from different height through modified outlets.

- Uses:

→ It used for separation of two immiscible liquid phases.
→ It used for separating liquid phases of emulsion in food, biochemical and pharmaceutical industries.

- Advantages:

→ It occupy small space.
→ Particles are separated into two difference size fractions.

- Disadvantages:

→ It is complicated construction and limited capacity.
→ It is not suitable for hard cake forming solids.

Unit: 5

Q-1: Write a details note on Corrosion?

- Theories of Corrosion:
- Types of Corrosion:

Ans:- Corrosion :- It is defined as the process of decomposition of metallic ~~met~~material in the presence of the environment through any electrochemical reaction.

→ It occurs may be presence of gases or vapour is called dry corrosion and due to attack of aqueous media is called wet corrosion.

→ It is a natural process.

e.g., Iron, rust etc. (formation of rust on iron).

• Theories of Corrosion :-

1- Acid theory.
2- Dry or chemical theory.
3- Galvanic theory.

1)- Acid theory of Corrosion :- This theory states that the acid cause corrosion of a metal. Carbon dioxide, atmospheric oxygen and moisture are ~~responsible~~ responsible for corrosion.

→ Rust represented as $Fe_2O_3.xH_2O$.

(i) Carbon dioxide react with ~~Hydrog~~ water in atmosphere form carbonic acid, which convert iron into iron bicarbonate.

$$Fe + 2CO_2 + H_2O + H_2CO_3 \longrightarrow Fe(HCO_3)_2.$$

(ii) → Ferrous bicarbonate is the oxidized by atmospheric oxygen to formed hydrated ferric oxide rust.

$$CO_2 + H_2O \longrightarrow H_2CO_3.$$

2) → Dry or Chemical theory of Corrosion → This theory states that corrosion is due to the reaction of atmospheric gases such as oxygen, halogens, sulphur oxides etc.

e.g. Alkali and alkaline earth metals reacts with oxygen at the room temperature and forms corresponding oxides.

3) → Galvanic theory of Corrosion → It is also known as Electrochemical theory.

→ When the ~~melt~~ metal or two dissimilar metal dipped fully in conducting liquid.

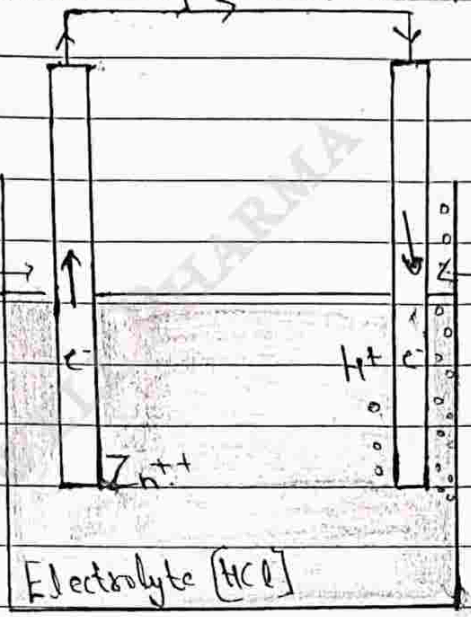
→ This cause formation of a galvanic cell on the metal surface.

→ Some part of metal surface act as anode and other part of metal surface rest as cathode.

→ Chemicals in environment act as electrolyte and cause oxidation of anodic part [corrosion at anode]

while reduction at cathode.

→ So, the formation of corrosion take place at the metals.



→ It occurs when current flow anode to cathode.

→ Two metals [Zn] anode & [Cu] cathode, when dipped electrolytic solution, they for galvanic cells.

→ When these two ~~electroly~~ electrodes are connected to wire, spontaneous reaction occurs.

- At anode [oxidation] → Indicates rough surface
  $Zn \longrightarrow Zn^{++} + 2e^-$
- At cathode [reduction] → It formation of bubbles at the surface $2H^+ + 2e^- \longrightarrow H_2\uparrow$.

→ When current flow, the anode metal get corroded.

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• Types of Corrosion :

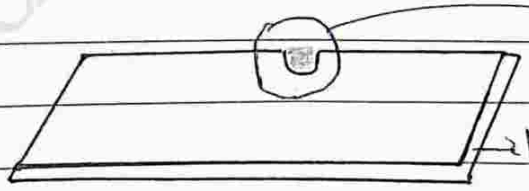
1. General Corrosion
2. Localised Corrosion
3. Structural Corrosion
4. Biological Corrosion.

1) General Corrosion → It is also known as Uniform attack corrosion.

→ It is most common type of corrosion and it is caused by the chemical or electrochemical reaction that damage the entire surface of the ~~root~~ metal.

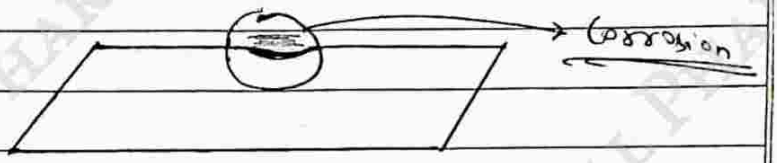
2) Localised Corrosion → This type of corrosion occurs at any particular area on a metal surface.

(i) Pitting Corrosion → It is occurs when a small hole is formed in the metal surface. That area becomes anodic, while a remaining metal become cathodic, produce localized galvanic reaction it produce corrosion.



(ii) → Crevice Corrosion → This is similar to pitting, crevice corrosion is occurs at a specific part.

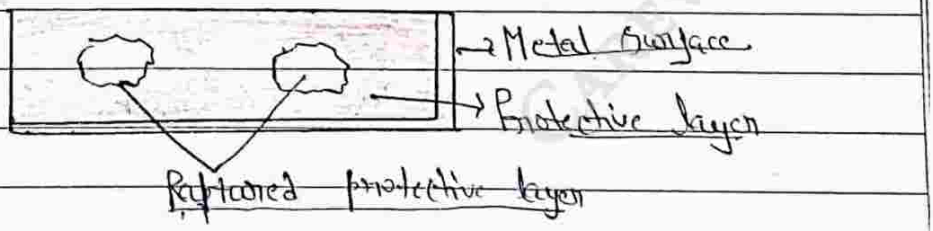
→ Solution get deposited to crevice and drying of the liquid take more time, as a result crevice corrosion occurs.



(iii) → Fretting Corrosion → It occurs as a result of repeated wearing of a metal on an uneven rough surface.

(iv) → Galvanic Corrosion → It occurs when two different metals are trap/noose/jand together in a corrosive electrolyte.

(v) → Corrosion fatigue → It occurs due to repetation, metal surface get corroded by corrosive media, Because, the protective oxide film that prevent corrosion get raptured.



3) → Structural Corrosion → In this type of corrosion, structural strength of metal get reduced due to corrosion.

e.g. Dezincification [de-alloying].

• Alloys → This is the mixture of many metals.

→ It is a process which selectively remove zinc from an alloy.

4) → Biological Corrosion → This type of corrosion, occurs due to metabolic activity of micro-organism which cause deterioration of a metal.

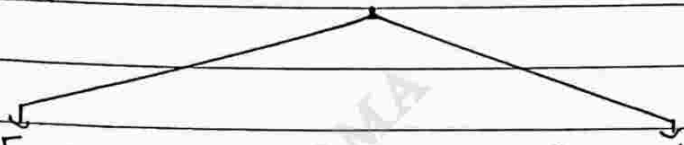
e.g. Anaerobes sulphate reducing bacteria in the soil produces hydrogen sulphite and calcium sulphite. When these compound comes in contact with underground piper, convert iron into ~~iron~~ iron sulphide [rust].

Q.2 → Describe the various factor affecting selection of the material for construction?

Ans → The selection of a material for the construction of

equipment depends on :

1. Chemical factors.
2. Physical factors.



Chemical Factors

- Contamination of the product.
- Corrosion of materials.

Physical Factors

- Strength
- Mass
- Wear Properties
- Thermal conductivity
- Ease to fabrications.
- Cleaning.
- Sterilization.
- Economic Factors.

i) **Chemical factors** → The material should be inert, because if the material of the equipment react with the drug than it change the properties of the drug.

ii) **Contamination of the product** → The material such as glass, silica, lead, cast iron, metal ion etc. are used in the construction of equipment produce contamination.

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→ If the impurities are present in this traces than they can cause decompose to products.

(ii) Corrosion of material → The material used for construction of equipment should be non-corrosion in nature.
Because, if the material should corrosive, they react with the drug and equipment get corroded result losing its strength and durability.
e.g. Some drug such as strong acid, strong basic, alkaloid are corrosive in nature & degrade equipment.
→ Mostly use stainless steel to prevent this.

2) Physical Factors :

(i) Strength → The material should be sufficient strength, because in manufacturing process of pharmaceuticals involves high pressure and high stress condition.
→ So, it material used for equipment has ability to tolerate [endure] these stresses. Iron & Steal.

(iii) → Mass → The material should be light in weight, because many times equipment are moves or transported from one place to another place. So, it is easy when material is light in weight.

(iii) → Wear Properties → These are possibility of reaction b/w the moving parts [material] and their are chance that some surface of material of equipment can contaminants into the drugs. So, it is also important in selecting materials.

(iv) → Thermal Conductivity → In some process, [during evaporation] their are use of high heat and this types of processes may be damages material [plastic, rubbers].
→ So, we have to use thermostable material for that types of processes.
eg, Stainless steel, iron etc.

(v) → Ease of fabrications → During fabrication, the material undergoes various process such as casting, forging, welding.
So, the material used can be easily moulded.
e.g, Glass, Plastic etc.

(vi) Cleaning → The material should have smooth and polished surface for easy cleaning.
e.g. Stainless steel and glasses etc.

(vii) Sterilization → In the production of parenterals, an opthalmic etc., sterilization is an essential step.
So, the material should be stable with it.

(viii) Economic factors → Before manufacturing, material's budget [cost] must be considered.
→ Initial costs and maintainance ~~cost~~ of plants must be economical.

Q-3- Write a short note on:

(i) Stainless Steel → It is an alloy of iron.
→ It contain 12 to 30% chromium, 0 to 2% nickel, low percentage of carbon, copper, molybdenum, selenium, tantalum and titanium.

- Uses → It is widely used in industries because, it is heat resistant, corrosion resistant, easily fabricated and have high tensile strength.

(ii) Glass → Glass container is widely used in daily life.

→ It is composed of sand [pure silica], soda ash [sodium carbonate], limestone [calcium carbonate] and cullet [broken glass].

→ Glass in its solid state is considered as supercooled liquids.

→ It is attractive in appearance, inert and cheap.

- Uses → It is widely used in pharmaceuticals industries and labs.

(iii) Rubber → It is a material, which can stretch and ~~st~~ shrink. It is a polymer. It can be produced from natural sources.

e.g., Natural rubber.

→ Natural Rubber → It is naturally occuring polymer, which is obtain as latex from rubber tree.

→ It include soft and hard rubber.

- Soft rubber → It is used as lining material for planks, as it can bond easily to the steel.

- Hard rubber → It is used for making glooves, bands, tubes etc.

• Synthetic → Rubber are more resistance to oxidation, solvents oils and other chemicals.

→ It include neoprene, nitril rubber, butyl rubber.

• Uses → It is used to lining material.