JRG College of Pharmacy

JRG COLLEGE OF PHARMACY

UNIVERSITY SOLVED QUESTION

WITH ANSWER

Year : 2019-2020

Subject : Pharmaceutical Engineering

Subject Code : BP304T

Subject In-Charge : Miss.Kiranmayee Bhatra

Registration No: | | | | | | | | | | |

Total Number of Pages : 01 **B.Pharm**
BP304T

3rd Semester Regular/Back Examination 2019-20
PHARMACEUTICAL ENGINEERING
BRANCH : B.Pharma
Max Marks: 75
Time : 3 Hours
Q.CODE : HBR749

Answer Question No.1 (Part-A) and 02 (Part-B) which are compulsory and any TWO from Part-C.
The figures in the right hand margin indicate marks.

Part-A

Q1 **Only Short Answer Type Questions (Answer All-10)** **(2 x 10)**

a) What is Reynolds Number? Show how it is dimensionless group.
b) Explain why the value of C_v is more than C_o in fluid flow.
c) Define Black Body and Grey Body.
d) Explain Stefan-Boltzmann law of thermal radiation.
e) What do you mean by economy of multiple effect evaporator ?
f) Why molecular distillation is also called short path distillation?
g) How EMC is measured?
h) Define convective mixing.
i) Write on the principle of Supercentrifuge.
j) Differentiate between simple distillation and fractional distillation.

Part-B

Q2 **Only Focused-Short Answer Type Questions- (Answer Any SEVEN out of NINE)** **(7 x 5)**

a) Describe the different laws governing size reduction.
b) Explain the size separation by elutriation tank.
c) Distinguish between Orifice Meter and Venturi Meter.
d) Write on the theories of corrosion.
e) What are the applications of centrifugation ?
f) Derive overall heat transfer coefficient from individual coefficients in forced convection.
g) Describe the advantages and disadvantages of Plate and Frame filter press.
h) Explain with the help of a diagram the construction and working of a ball mill.
i) What are the parameters which should be maintained in primary drying step i.e. sublimation of ice under vacuum in freeze drying.

Part-C

Only Long Answer Type Questions (Answer Any TWO out of FOUR)

Q3 Describe principle, construction, working, advantages and disadvantages of Silverson Mixer Emulsifier **(10)**

Q4 Derive Bernoulli's equation and what are the application of Bernoulli's theorem. **(10)**

Q5 Explain the factors affecting during materials selected for Pharmaceutical plant construction. **(10)**

Q6 With a labeled sketch, explain the principle, construction, working, advantages and disadvantages of Fluidised Bed Dryer. **(10)**

Pharmaceutical Engineering
PYQ :- 2019-20

Q.11
a) What is Reynolds number ? show how it is dimensionless group.

Ans:- The Reynolds no. (Re) is a dimensionless quantity used in fluid mechanism to predict flow patterns, representing the ratio of inertial forces to viscous forces. It is dimensionless because it is a ratio of 2 quantities with the same physical dimensions, causing them to cancelled.

$$Re = \frac{\text{Internal Force}}{\text{Viscous Force}}$$

b) Explain why the value of Cv is more than Co in fluid flow.

Ans:- In fluid dynamics, the coefficient of velocity (Cv) is greater then the Co because they describe diff. aspects of energy loss & fluid behavior as it exits an orifice.

c) Define black body & Grey body ?

Ans:- A black body is an idealized object that absorbs all electromagnetic radiation falling on it & , when heated, emits radiation in a continuous spectrum that depends only on its temp.

→ A grey body is a theoretical object in physics that has a constant emissivity less than 1 across all wavelengths of radiation.

d) Explain Stefan - Boltzmann law of thermal radiation ?

Ans:- The Stefan - Boltzmann law states that the total energy radiated per unit surface area of a blackbody is directly proportional to the fourth power of its absolute temp.

→ $P/A = \sigma T^4$

→ [p - 0.5 ATM]

e// What do you mean by economy of multiple effect evaporation?

Ans: The "economy" of a multiple-effect evaporator refers to its energy efficiency, defined as the amount of vapor produced per unit of steam supplied.

f// Why molecular distillation is also called short path distillation?

Ans: Molecular distillation is called short path distillation because the distance bet^n the Evaporator & the condenser is very short, usually only a few centimeters.

g// How EMC is measured?

Ans: EMC is measured through two main types of tests:

(1) Emissions testing
(2) immunity testing.

h// Define convective mixing?

Ans: A convective mixing is a process driven by the bulk movement of material within a system, such as fluids or solid particles.

i// Write on the principle of supercentrifuge

Ans: The super centrifuge or tubular bowl centrifuge operates on the principle of sedimentation, separating immisible liquids or fine solids from a liquid based on density differences.

Q// Differentiate betn simple distillation & fractional distillation?

Ans: Simple & fractional distillation both separate liquid mixtures, but the key difference is the boiling point diff. betn the components they can separate. Simple distillation work for liquid with large boiling point diff, while fractional distillation is used for liquid with close boiling points.

PART - B

Q1 Only Focused - short Answer Type Questions.

(a) The different laws governing size reduction -

There are mainly 3 laws that governs the process of size reduction :-

(1) Kick's Law
(2) Rittinger's law
(3) Bond's law

Kick's Law

According to this law, the energy required to reduce the size of the partices is directly proportional to the ratio of size reduction.

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

Here K_k = Kick's Constant
d_1 = Initial Diameter
d_2 = Final Diameter

Rittinger's Law

According to this law, energy required for size reduction is directly proportional to the new surface area produced.

$$E = K_K (S_n - S_i)$$

Here K_K = Rittinger's constant
S_n = New surface Area
S_i = Initial surface Area

Bond's law

This law states that energy required for size reduction is proportional to the new crack length

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

Here, E = Energy Required
W = Bond's work index

d_1 = Diameter of sieve that allow 80% of Feed mass to pass

d_2 = Diameter of sieve that allow 80% of grand mass to pass

(b) Explain the size separation by elutriation tank.

Size separation by elutriation tank is a technique used to separate particles based on their size and density in a fluid medium, typically water or air. Here's how it works:-

* Principles:-

- Fluid Dynamics:- The elutriation tank utilizes upward fluid flow to carry particles of varying sizes.
- Gravity Separation:- Heavier particles settle faster due to gravity, while lighter particles remain suspended or settle more slowly.

* Construction:-

- Vertical tank:- The elutriation tank is typically a vertical structure with an inlet fluid introduction.
- Inlet and outlets:- Fluid enters from the bottom; outlets collect separated particles.

* Working:-

1. Fluid Introduction: Fluid (air or water) flows upward in the tank.
2. Particle Suspension:- Particles are entrained based on their size and density.
3. Separation: Particles separate based on setting velocities; coarser particles settle at the bottom.

Uses:-

- Particle classification:-
Common in mineral processing, pharmaceuticals, and chemical industries.
- Density separation:- Applicable for separating particles based on density.

- Wastewater Treatment: Used For sediment removal.

* Advantages:-

- High precision: EFFective For separating particles based on size and density.
- continuous operation: can operate continuously.
- Gentle Separation: suitable For Frugile materials.

Disadvantages:-

- Complex setup: Requires careful calibration.
- Energy consumption: May consume significant energy depending on scale.
- Limited Applicability: primarily For size and density separation.

(c) Difference between Orifice meter and venturi meter?

> Installation Requirements:
>
> (•) Orifice meters require straight pipe lengths upstream and downstream
>
> (•) Venturi meters also require straight pipe lengths, but typically less than Orifice meters.

(•) Orifice Meter is simple, cost effective

(•) Venturi meter is more accurate, less pressure loss

(•) Orifice Meter required more straight pipe length.

(•) Venturi meter generally costlier.

(•) Orifice meter are generally cheper to Install as compair to Venturi meter.

(•) Venturi meters have a converging-diverging tube, orifice meters use a plate.

(•) Maintenance - Orifice meter are simpler to maintain and replace as compair to venturi meters

(•) Flow Range: Venturi meters can handle wider flow ranges.

(d)

THEORIES OF CORROSION :-

(a) Acid theory

(b) Dry [chemical theory]

(c) Electrochemical theory (Galvanic theory)

(a) Acid theory of corrosion

↳ This theory states that the acid cause corrosion of a Metal. CO_2 (carbon dioxide), atmospheric oxygen and moisture are responsible for corrosion.

↳ Rust represented as $Fe_2O_3 \cdot nH_2O$

(i) Carbon dioxide react with water in atmosphere from carbonic acid, which convert iron to iron bicarbonate

$$Fe + 2CO_2 + H_2O + H_2O_2 \longrightarrow Fe(HCO_3)_2$$

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

$$2Fe(HCO_3)_2 + 1/2\,O_2 \longrightarrow 2Fe(OH)(CO_3) + 2CO_2 + 2H_2O$$

$$2Fe(OH)(CO_3) \longrightarrow Fe_2O_3 + 2CO_2 + H_2O$$

$$Fe_2O_3 + nH_2O \longrightarrow Fe_2O_3 \cdot nH_2O$$

(b) 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.

eg// Alkali and alkaline earth metal react with oxygen at room temperature and forms corresponding oxides.

(c) Galvanic theory of Corrosion :-

When the metal are two dissimilar metal dipped partially or fully in conducting liquid.

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

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

↳ chemicals in environment act as electrolyte and cause oxidation of anodic part while reduction of cathode.

↳ So formation of corrosion take place at metals.

↳ It occurs when current flow from anode to cathode

↳ Two metal (Zn) anode and (Cu) cathode when dipped electrolytic sol, they for galvanic cells.

↳ When these two electrodes are connected to wire, Spontanious reaction occurs.

↳ At anode (oxidation) :- Indicate rough surface.

$$Zn \longrightarrow Zn^{++} + 2e^-$$

↳ At cathode (reduction) :- Formation of bubbles at surface

$$2H^+ + 2e^- \longrightarrow H_2\uparrow$$

↳ When current flow, the anode metal get corroded.

(e) Application of Centrifugation :-

- Isolation of active pharmaceutical Ingredient from impurities.
- Separation of blood Component
- Isolating cellular Component for desease diagnosis
- Separation of Cream form milk
- Removal of impurities from oils and lubricants.
- Isolating & purifying proteins, enzymes or antebodies.

(F) Derive overall heat transfer coefficient from individual coefficients is forced convection.

The overall heat transfer coefficient (U) can be derived from individual heat transfer coefficients in forced convection using the following steps.

- Resistances in series:

1. Convection resistance on the hot side : $1/h_1$ (where h_1 is the convective heat transfer coefficient on the hot side).
2. Conductive resistance of the wall : $\Delta x/k$ (where Δx is the wall thickness and k is the thermal conductivity of the wall material).
3. Convective resistance on the cold side : $1/h_2$ (where h_2 is the convective heat transfer coefficient on the cold side).

* Overall Heat transfer coefficient

The overall heat transfer coefficient (U) is given by: $1/U = 1/h_1 + \Delta x/k + 1/h_2$

* Derivation:-

The heat transfer rate (Q) can be expressed as:-

$$Q = h_1 A (T_1 - T_2) = kA/\Delta x (T_2 - T_3) = h_2 A (T_3 - T_4)$$

A = heat transfer area

T_1 and T_4 = bulk fluid temperature on the hot and cold sides.

T_3 & T_2 = Temp^n. at the wall surface

Rearranging and combining these equations, we get:- $Q = UA(T_1 - T_4)$

U = overall heat transfer coefficient.

*Expression For U :-

The expression For U can be written as:-

$1/U = 1/h_1 + \Delta x/k + 1/h_2$

* Units :-

The units of U are typically W/m^2k.

* Importance :-

The overall heat transfer coefficient (U) is a critical parameter in designing and analyzing heat transfer equipment, such as heat exchangers.

(g) Describe the advantages and disadvantages of plate and Frame Filter press.

plate and Frame Filter press

* Advantages :-

- It provides large Filtering area
- Efficient washing of the cake is possible
- High Filteration efficiency
- Customizable
- Handles High pressure

* Disadvantages :-

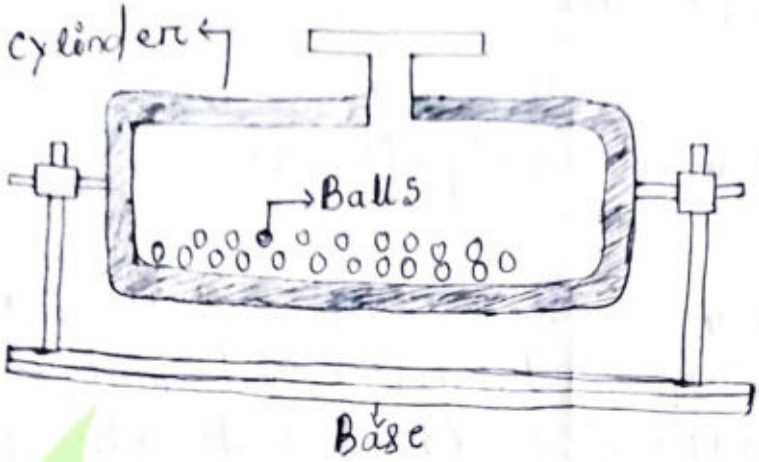
- Time consuming
- space Requirements
- It is a batch Filter
- It is an expensive Filter

(h) Explain with the help of a diagram the construction and working of a ball mill.

Ball Mill

- Ball Mill is one of the type of grinder used to grind or blend materials into superFine powd
- These powders are further used in mineral

dressings, paint & ceramics.



* Construction & working

- The ball mill consist of a hollow cylinder mounted on a shaft & rotating about its horizontal axis.
- The cylinder contain balls generally made of metals that occupies 30 - 50% volume of the cylinder.
- The drug to be ground is placed inside the cylinder along with balls to about 60% volume of the cylinder.
- The mill is allowed to rotate on a correct speed.

(i) What are the parameters which should be maintained in primary drying step i.e. sublimation of ice under vacuum in freeze drying.

In primary drying, also known as the sublimation phase, of freeze-drying, it's crucial to maintain the product temperature below the eutectic point or collapse temperature to prevent melting or collapse of the product structure.

However, the specific parameter you're referring to, "sublimation of ice on the vacuum," seems to relate to maintaining the ice in a frozen state while applying vacuum. For effective primary drying:

1. Temperature :- The product temperature should remain below the eutectic point to keep ice From melting.

2. Vacuum pressure :- The chamber pressure should be controlled to Facilitate sublimation without exceeding the critical pressure that would cause melting.

By Maintaining these conditions, the ice can sublimate directly From solid to vapor without passing through the liquid phase, preserving the products structure.

: PART-C :-

only Long Answer Type Questions.

Q3. Describe Principle, construction, working advantages and disadvantages of Silverson Mixer Emulsifier.

Ans:-

SILVERSON EMULSIFIER :-

Principle :-

→ The Silverson emulsifier operates on the principle of high speed shearing.

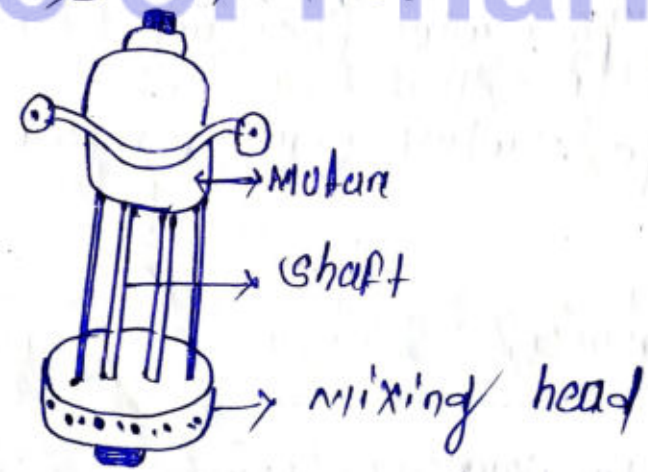
→ A rapidly rotating rotor generates intense shear forces and turbulence which break down larger droplets into smaller ones, resulting in a fine & stable emulsion.

Construction :-

→ Motor :- Drives the central rotating shaft.

→ Shaft :- connects the motor to the mixing head.

→ Mixing head :- Located at the end of the shaft, it contains turbine blades surrounded by a perforated metal sheet & an outer cover with openings.



Working :-

→ The mixing head is fully immersed in the liquids to be emulsified.

→ The motor spins the shaft and mixing head at high speed.

→ The turbine blades create a pressure difference, drawing liquids into the mixing head.

→ Inside the head mixing occurs, breaking down larger droplets.

→ The process repeats, ensuring a proper mixing & uniform emulsion.

Advantages :-

→ Rapid mixing

→ versality

→ Particle size reduction.

Disadvantages :-

→ Mesh clogging.

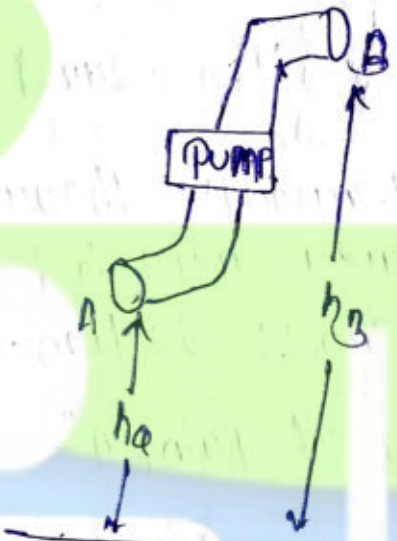
→ Energy consumption.

Q4. Derive Bernoulli's equation & what are the application of Bernoulli's theorem.

Ans :- **Bernoulli's theorem :-**

→ Bernoulli's theorem is based on law of conservation of energy.

→ Bernoulli's theorem states that the sum of total energy per unit volume remains constant at any cross-section of the pipe throughout the fluid flow.



Total pressure per unit volume at Point "A" :-

→ Potential energy per unit volume at A = $\frac{mgh}{V} = \rho gh$

→ Pressure energy per unit volume at A = $\frac{P_A V}{V} = P_A$

→ Kinetic energy per unit volume at A = $\frac{1}{2}\frac{mv^2}{V}$

$= \frac{1}{2}\rho v_A^2$

Now According to Bernoulli's theorem

$$P_A + \rho g h_A + \frac{1}{2}\rho v_A^2 = \text{constant}$$

Total Pressure Per unit volume at Point "B" :-

→ Potential energy per unit volume at B = $\frac{mgh_B}{V}$
$= \rho g h_B$

→ Pressure energy per unit volume at B = $\frac{P_B V}{V}$
$= P_B$

→ Kinetic energy per unit volume at B = $\frac{1}{2}\frac{mv_B^2}{V}$
$= \frac{1}{2}\rho v_B^2$

Now according to bernoulli's eq?

$$\boxed{P_B + \rho g h_B + \frac{1}{2}\rho v_B^2 = \text{constant}}$$

→ Now According to bernoulli's theorem the sum of total energy remains constant or same at any cross section.

→ Hence, Total energy at Point "A" = Total energy at Point "B"

$$\boxed{P_A + \rho g h_A + \frac{1}{2}\rho v_A^2 = P_B + \rho g h_B + \frac{1}{2}\rho v_B^2}$$

→ Now If we divide the above eq?. by ρg, we get

$$\boxed{\frac{P_A}{\rho g} + h_A + \frac{v_A^2}{2g} = \frac{P_B}{\rho g} + h_B + \frac{v_B^2}{2g}}$$

→ The above eq?. is called as Bernoulli's eq?. in terms of Pressure head, where

→ $\frac{P_A}{\rho g}$ = Pressure head at "A"

→ $\frac{P_B}{\rho g}$ = Pressure head at "B"

→ h_A = Potential head at "A"
→ h_B = Potential head at "B"
→ $\frac{v_A^2}{2g}$ = Kinetic head at "A"
→ $\frac{v_B^2}{2g}$ = Kinetic head at "B"
→ Now Practically, for transportation of fluid, Pump added certain amount of energy, that can be expressed as = w
→ Also during, the transport some energy get lost in the form of heat due to frictional forces, can be expressed as = F
→ Now, After combining above two factors in our Bernoulli's eq., we get,

$$\frac{P_A}{\rho g} + h_A + \frac{v_A^2}{2g} + w - F = \frac{P_B}{\rho g} + h_B + \frac{v_B^2}{2g}$$

Application of Bernoulli's theorem :-

→ Working of Centrifugal Pumps.
→ Working of venturi meter, Pitot tube, Orifice meter etc,
→ Working of Aeroplane.
→ Blowing of Roofs.

Q5. Explain the factors affecting during Materials selected for Pharmaceutical Plant construction.

Ans :- The selection of a material for the construction of equipment depend on :-

(1) Chemical factors
(2) Physical factors

(1) Chemical factors :-

The material should be inert because if the material of equipment react with drug than it change the properties of drugs

(a) Contamination of the Product :-

The material such as glass, silica, cast iron, Material iron etc, are used in the construction of equipment produce contamination.

→ If the impunities are present in this traces than they can cause decompose to product.

(b) Corrosion of Material :-

→ The material used for construction of equipment should be non corrosive in nature.

→ Because, if the material should corrosive they react with drugs & equipment get corrod

reason testing the strength & durability.

(2) Physical factors :-

(a) Strength :- The material should be sufficient strength because in manufacturing process of Pharmaceuticals involves high pressure & high stress condition.

→ So, the material used for equipment have ability to tolerate these stresses.

(b) Mass :- The material should be light in weight, because many times equipment are transported or removed.

So, it is possible when material is light in weight.

(c) Ease of fabrication :-

During fabrication, the material is undergoes various process such as casting, forging, welding.

So, the material used can be easily moulded e.g :- glass, plastic.

(d) Cleaning :- The material should have smooth & polished surface for easy cleaning.

→ Stainless steel & glass etc.

(e) Sterilization :- In the production of Parenterals, Opthalmic etc., Sterilization is an essential step.
→ So, material should be stable with it.

8) Economic factors :- Before manufacturing, materials budget must be considered!
→ Material cost & Maintainance of Plants must be economical.

Q6. With a labeled Sketch, explain the construction, working, advantages & disadvantages of fluidised Bed dryer.

Ans:- FLUIDISED BED DRYER :-

Principle :-
Fluidised bed dryer operates on the Principle of fluidization, where a bed of solid particles is transformed into a fluid-like state by passing a stream of hot air through it.

Construction :-
→ Chamber :- A closed chamber typically made of Stainless Steel.

→ Perforated Plate :- A perforated Plate at the bottom of the chamber allows to passage of hot air

Here, E

→ Fan :- A fan to distribute hot air evenly across Plate.

→ Heating system :- A heater to heat the air.

→ Air Inlet :- Inlet through which air enters.

→ Filter Bags :- Prevent solid particles from escaping.

Working :-

→ The wet material is fed into the chamber.

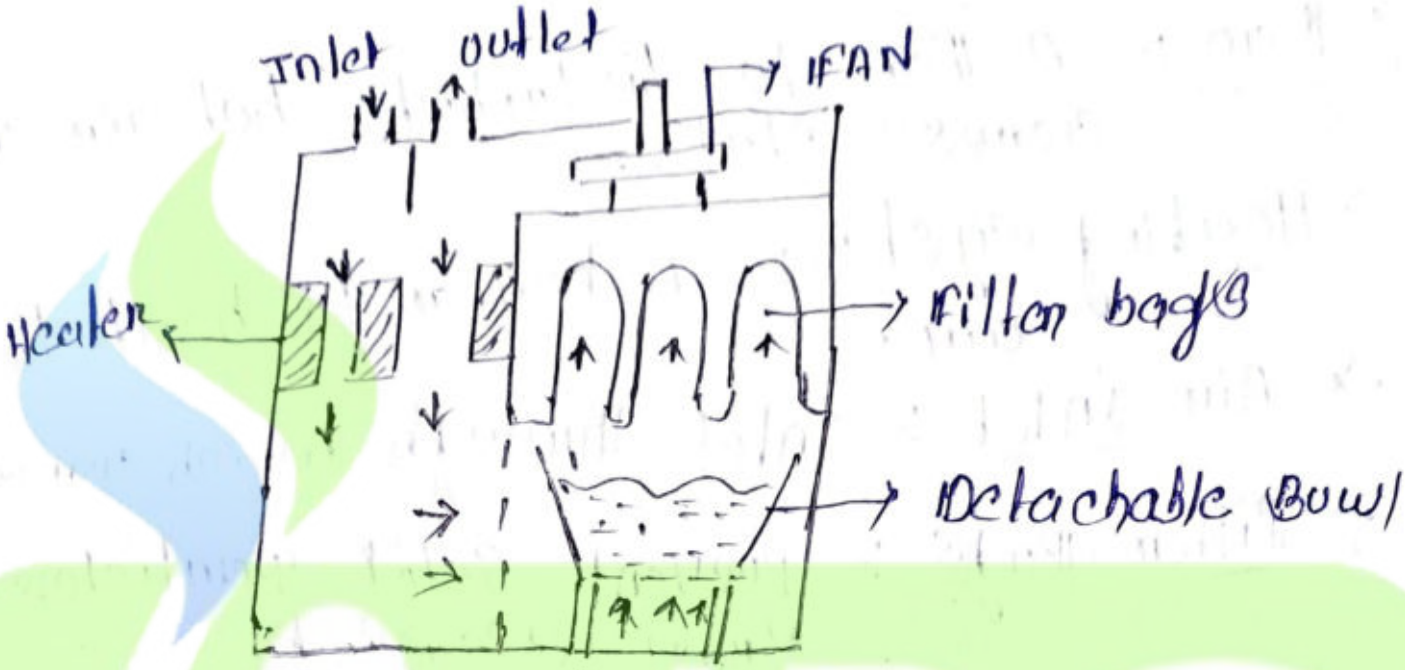
→ Heated air is passed through the perforated base plate at high velocity.

→ The material particles are lifted & suspended in the air stream, behaving like a fluid.

→ The hot air transfers heat to the particles, causing moisture to evaporate.

→ The moist air is removed through the exhaust system

→ The dried material is discharged after drying process is complete.



Advantages :-

:- Efficient Drying
:- uniform Drying
:- Versable

Disadvantages :-

:- High initial cost
:- Not suitable for sticky material.