

JRG COLLEGE OF PHARMACY

UNIVERSITY SOLVED QUESTION WITH ANSWER

Year : 2021-2022

Subject : Pharmaceutical Engineering

Subject Code : BP304T

Subject In-Charge : Kiranmayee Bhatra



Registration No:

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Total Number of Pages: 02

B.Pharm
BP304T

3rd Semester Regular / Back Examinations: 2021-22

PHARMACEUTICAL ENGINEERING

BRANCH: B.Pharma

Time: 3 Hours

Max Marks: 75

Q. Code: OF662

Answer Question No.1 (Part-I) which is compulsory, any seven from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions: (2×10)

- Distinguish between drying and evaporation?
- List out the different mechanisms of size reduction?
- Define equilibrium moisture content and critical moisture content?
- Define black body and grey body?
- What are the various grades of powders official in pharmacopoeia?
- State Raoult's law and its significance in distillation?
- What are the different modes of feed supply in multiple effect evaporator?
- What is meant by dead spot in the mixing equipments and how it can be prevented?
- What is overall heat transfer coefficient?
- Discuss about Stefan-Boltzmann law in heat transfer by radiation?

Part-II

Q2 Focused-Short Answer Type Questions: (Answer Any Seven) (5×7)

- What are the reasons for vortex formation and how it can be prevented?
- What are filter aids? How they facilitate the process of filtration?
- How multiple effect evaporators are more economic than single effect evaporators?
- What is corrosion? Discuss about the theories of corrosion?
- Describe the construction and working of fluid energy mill?
- Explain the working of cyclone separator and its usefulness?
- Describe construction and working of supercentrifuge?
- What is Reynold's number? Discuss its significance?
- Describe the principle and applications of steam distillation?

Part-III

Long Answer Type Questions (Answer Any Two)

- Q3** Write in detail on principle, construction, working, advantages and disadvantages of fluidized bed dryer? **(10)**
- Q4** State Fourier's law? Derive an equation for heat transfer by conduction through a uniform metal wall? Discuss the application of thermal conductivities? **(10)**

Q5 Derive Bernoulli's equation stating the assumptions? Discuss the various applications of Bernoulli's theorem? **(10)**

Q6 Write in detail on principle, construction, working, advantages and disadvantages of rotary drum filter? **(10)**

2 marks

1(a) Distinguish between drying and evaporation?

1) Drying : A process of removing moisture from a solid or semisolid material, usually with the help of heat, air and other drying agent.

- purpose : To reduce moisture content for preservation stability or further processing.

- method : Heat, air flow or vacuum is used to speed up moisture removal from solids.

Example : Removing water from wet clothes, drying pharmaceutical powders, drying grains.

Evaporation : A surface phenomenon where liquid molecules escape into vapor state at temperatures below the boiling point.

purpose : To concentrate solution by removing solvent.

method : only requires heat for liquid $\rightarrow$ vapour conversion.

Example : water in pond slowly disappearing under the sun concentrating sugar solution to make syrup.

b) List out the different mechanism of size reduction.

1) Mechanisms of size reductions are : The mechanism of size reduction also called comminution refers to how large solid particles are broken down into smaller ones. It mainly involves the application of mechanical forces. The main mechanisms are
 cutting - blades
 compression - crushing pressure
 impact - sudden strike
 Attrition - rubbing / shearing

c) Define equilibrium moisture content and critical moisture content?

1) Equilibrium moisture content $\div$ The moisture level at which a material (like food, grain or drug powder) doesn't lose or gain water from the air.

Critical moisture content $\div$ The moisture level at which drying rate starts to slow down.
~~top~~ above this point drying is fast or below the point drying is slow.

d) Define black body and grey body?

1) Black body $\div$ A ideal body that absorbs all the radiation (100%) falling on it, regardless of wavelength or angle.

- It is a perfect absorber and perfect emitter of radiation.

Grey body $\div$ A real body that absorbs only a fixed fraction of the radiation falling on it (less than 100%) the fraction being the same for all wavelengths.

- Absorptivity $\propto$ 1 but constant.

e) What are the various grades of powders official in pharmacopoeia?

1) In pharmacopoeia powders are classified based on the fineness of their particles.

1) Coarse powder - particles pass through the sieve no 10 and not more than 40.

2) Moderately coarse powder - particles pass through sieve no 22 and not more than 60.

moderately fine powder: particles pass through sieve no. 44 and not more than 85.

fine powder: particles pass through sieve no. 85.

very fine powder: particles pass through sieve no. 120.

micron fine powder: particles of very small size often measured in microns.

f) Define Raoult's law and its significance in distillation.

1) Raoult's law states that the partial vapour pressure of a component in a liquid mixture is equal to the vapour pressure of the pure component multiplied by the mole fraction in the mixture.

where $P_A = P_A^0 \times x_A$

where P_A = partial vapour pressure of component A

P_A^0 = vapour pressure of pure A.

x_A = mole fraction of A in the liquid.

Significance in distillation

- Distillation works by a separating liquids based on their differences in boiling point.

- According to Raoult's law, the composition of vapor is different from the liquid $\rightarrow$ vapor is richer in the more volatile component.

- This difference allows step by step separation of components when the vapor is condensed and collected.

- Basic for simple distillation, fractional distillation and azeotropic distillation.

g) what are the different modes of feed supply in multiple effect evaporator?

A) In a multiple effect evaporator, feed can be supplied in different ways depending on the material and energy efficiency. The main modes of feed supply are:

- Forward feed
- Backward feed
- mixed feed
- parallel feed.

h) what is meant by dead spot in the mixing equipments and how it can be prevented?

A) A dead spot is a region inside a mixing vessel where the fluid remains almost unstirred or unmixed.

It can be prevented by:

- proper agitator design
- use of baffles
- Right agitator speed
- multiple impellers
- changing vessel geometry.

i) what is overall heat transfer coefficient?

A) It is a measure of how easily heat is transferred through a series of resistance like metal wall, scale deposits between two fluids at different temperature.

mathematically $Q = U \cdot A \cdot \Delta T$

Q = heat transferred

U = overall heat transfer coefficient

A = heat transfer area

ΔT = Temperature difference

Q. Discuss about Stefan-Boltzmann law on heat transfer by radiation?

1) It is a fundamental law of thermal radiation that relates the heat radiated by a body to its absolute temperature.

mathematically form

$$q = \sigma T^4$$

q = radiant heat energy emitted per unit area (W/m^2)

T = absolute temperature of the body

σ = Stefan Boltzmann constant = $5.67 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$

Part-II

Q2) a) What are the reasons for vortex formation and how it can be prevented?

1) A vortex is a swirling funnel-shaped motion of liquid that forms when liquid is drained or stirred in a vessel.

Reasons for vortex formation in mixing

1. High stirrer ÷ liquid is pulled strongly downwards creating a central dip.
2. Axial flow pattern ÷ pushes liquid down and forms a whirl.
3. insufficient baffles ÷ liquid rotates with the impeller instead of proper mixing, leading to vortex.
4. Low liquid level in tank ÷ more air entrainment and easier vortex development.
5. viscosity too low ÷ thin liquids are more prone to vortex compared to viscous liquid.

problems caused by vortex:-

- poor mixing efficiency.
- uneven distribution of solute.
- mechanical stress impeller.

Prevention of vortex formation:-

- use baffles
- proper impeller position
- Reduce stirrer speed
- change flow pattern
- maintain sufficient liquid level in tank.

b) What are filter aids? How they facilitate the process of filtration?

1) filter aids are inert, insoluble, and finely divided substances that are added to the liquid being filtered to improve the filtration process.

Why are the filter aids needed?

- The solid particles are very fine and block filter pores.
- A compressible cake is formed that resists liquid flow.

• Filtration becomes very slow.

How filter aids facilitate filtration form a porous cake

- filter aids create a loose porous structure - liquid can pass easily.

Prevent clogging of filter medium

fine particles cannot directly block the pores, because they are trapped in

the porous matrix.

3. Increase filtration rate:

- By reducing resistance to flow.

4. produce a clear filtrate:

fine suspended solids are trapped more effectively.

5. Act as a protective precoat

method of using filter aids:

- precoat method.
- Body feed method.
- combination method

C) How multiple effect evaporator are more economic than single effect evaporator?

A) Single effect evaporator:

- used one vessel
- steam supplied - liquid boils $\rightarrow$ vapour produced $\rightarrow$ vapour condensed and usually wasted.
- only one kg of steam evaporates about one kg of water.

Multiple effect evaporator:

- consists of two or more evaporator vessel connected in series.
- steam is given to the first effect.

- The vapour generated from the first effect is used as the heating medium for the second effect.

- The vapour from the second effect is used to heat the third effect and so on.

Why more economic:-

1) Steam economy

in a single effect: 1 kg steam $\rightarrow$ 1 kg water evaporated.

In an N-effect evaporator $\rightarrow$ 1 kg steam $\rightarrow$ N kg water evaporated.

Example: 4-effect evaporator $\rightarrow$ 4 kg water evaporated per kg steam.

2) Lower steam consumption

3) Efficient use of energy.

4) Better suited for large scale operation.

d) What is corrosion? Discuss about the theories of corrosion?

A) Corrosion is the gradual destruction or deterioration of a metal due to its chemical or electrochemical reaction with the environment.

Example: Rusting of iron

There are mainly two important theories

1. Dry (Chemical) Theory of Corrosion:

- corrosion occurs due to direct chemical reaction of metal with gases like O_2 , SO_2 , Cl_2 in dry condition.

Example:

oxidation of metals at high temperature $\rightarrow$ formation of oxide layer



Characteristics

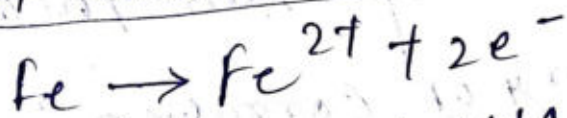
- No electrolyte needed
- Common in high temperature furnaces, boilers, gas plants (wet)

Electrochemical Theory of Corrosion

- most common type (like rusting of iron)
- occurs when metal surface has moisture act like a tiny electrochemical cell
- In presence of water + dissolved O_2 some parts of metal act as anode, other as cathode

Steps

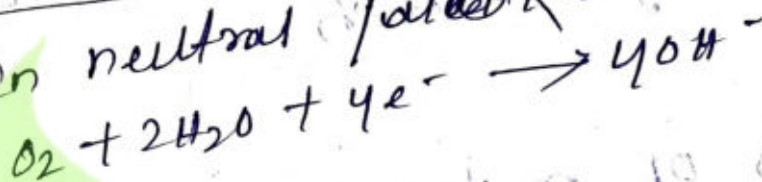
At anode (oxidation)



metal atoms lose electrons.

At cathode (reduction)

In neutral / ~~acidic~~ ^{alkaline} medium



formation of rust



c) Describe the Construction, and working of fluid energy mill.

1) It consists of a grinding chamber with tangential air nozzles, a feed inlet and classifier outlet. Compressed air or inert gas enters the nozzles at high velocity. The chamber is usually made up of stainless steel and fine particles are collected through a cyclone separator.

Working

High pressure air creates turbulence inside the chamber. The feed particles collide with each other and the air stream, leading to the size reduction by impact and attrition. Fine particles are carried to the outlet, while coarse ones remain for further grinding.

uses

- used for producing very fine powder of heat sensitive drugs like antibiotics and steroids.

f) Explain the working of cyclone Separator and its usefulness?

A) A cyclone separator works on the principle of Centrifugal force. The dust-laden air or gas enters tangentially at high speed into the cylindrical body, creating a spiral motion. The heavier dust particles are thrown outward toward the wall by Centrifugal force and fall to the bottom, while the clean air moves upwards through the central outlet tube and is discharged.

Usefulness

- Efficiency removes solid particles from air or gas.
- Used as pre-cleaner before filters.
- Simple, no moving parts, and low maintenance.
- Commonly used in pharmaceutical, Chemical, and Cement industries.

g) Describe Construction and working of Centrifuge?

A) A centrifuge consists of a metallic perforated basket mounted on a spindle that rotates at a high speed inside a stationary outer casing. The basket is lined with a filter cloth to hold the solids. The whole system is driven by an electric motor and provided with the arrangement for feeding and discharge materials.

working :- The suspension is fed into the rotating basket when the basket spins at high speed, centrifugal force acts on the mixture - the liquid phase passes through the filter medium and perforation, while solid particles remain on the inner wall of the basket. After separation, the solids are removed automatically.

h) What is Reynold's number? Describe its significance.

1) Reynold's number (Re) is a dimensionless number that helps to predict type of ~~flow~~ flow of a fluid through a pipe or around an object.
it given a formula

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

ρ = density of fluid

v = velocity of fluid

D = Diameter of pipe

η = viscosity of fluid

Significance

It determines the flow pattern of a fluid

• $Re < 2000$ - Laminar flow (smooth)

$Re \approx 2000$ - low - Transitional flow

$Re > 4000 \rightarrow$ Turbulent flow

- helps in design equipment like pipes, pumps, and heat exchangers for efficient fluid transport.

ii) Describe the principle and application of steam distillation?

1) Steam distillation is based on the principle that when two immiscible liquids are heated together, each exerts its own pressure independently.
- The total vapour pressure is the sum of both, so the mixture boils at low temperature than the boiling point of either liquid alone.
This provides decomposition of heat sensitive substances.

Application

- used for extraction of essential oils from plants
- for purification of organic compounds that are immiscible with water and decompose at high temperature.
- used in the manufacture and pharmaceuticals.

Long question answer

- ① Write detail about the principle, construction, working advantage and disadvantage of fluidized bed dryer.
- ② The fluidized bed dryer works on the principle of fluidization when a gas is passed upward through a bed of solid particles at a certain velocity, the particles behave like a fluid. This ensures uniform heat and mass transfer, resulting efficient drying.

Construction :

Air inlet :- From air drawn by a blower

Preheater :- The air is heated to the desired temperature.

Drying chamber :- A container made up of stainless steel where granules are loaded.

Filter bags :- Placed at the top to prevent fine particles from escaping with the air.

Working :

- The air flows upwards and lift the wet granules forming a fluidized state.
- The hot air contact all surface of the particles evaporating the moisture rapidly.
- The moist air passes through the filters and is exhausted, while dried material is collected after drying.

Applications

- Drying granules and powders in the pharmaceutical industry.
- Used food and chemical, polymer industries.

Advantage

- Fast and uniform drying
- Short time drying and high efficiency.
- Easy to clean and operate

disadvantage

- High initial cost
- Not suitable for heavy and sticky materials

2) Derive Bernoulli's equation? Discuss about the various application about this theorem?

1) Bernoulli's equation state that for steady, incompressible and non viscous fluid flow, the total energy per unit weight of the fluid remains constant along streamline.

$$\frac{P}{\rho g} + \frac{v^2}{2g} + h = \text{Constant}$$

where

P = pressure energy

v = velocity of fluid

h = height above reference level

ρ = Density of fluid

g = Acceleration due to gravity

Application

1. Venturimeter: To measure rate of fluid through pipe.
2. Orifice meter: for determining discharge through
3. Pitot tube: To measure fluid velocity.

3) write about the principle, construction, advantage and disadvantage about rotary tablet machine?

1) Construction - A rotary tablet machine consists a hopper, feed frame, dies and punches arranged on a rotating turret a compression unit, and a motor for driving rotation.

- working :

- granules from the hopper flow into the dies through feed frame.
- As the turret rotates the lower punch moves down to fill the die.
- The upper punch then moves down to compress the granules into a tablet.
- the process continuously for mass production.

Advantages

- High production rate
- Uniform weight, and size of tablets
- Easy operation.

Disadvantage

- High cost
- Not suitable for small scale production.

Thank you
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