UNIT: III **(MIXING)**

CLASS:28

**TOPIC: LIQUID MIXING AND SEMISOLIDS MIXING, PROPELLERS, TURBINES, PADDLES & SILVERSON EMULSIFIER**

## MIXING DEVICES-FLOW PATTERN

Mixing devices are used to supply energy to the system so long as to bring about reasonably rapid mixing. Flow currents are responsible for transporting unmixed materials to the mixing zone.

Mixing devices are technically called-as impellers. Impellers are classified on the basis of the shape arid pitch of the blades that are attached to the central shaft. Three main types of impellers are used namely. Propellers, turbines and paddles.

## Propellers

Propeller normally contains a number of blades (Figure). A three bladed design is the most common for liquids. The marine type Propeller is similar to the blades of a table fan or a ceiling fan.


(a) Side view (b) Top view (Propeller type of mixing devices. A three bladed design.)

Propellers may be either right or left-handed, depending on the direction of slant of their blades) Four bladed or toothed or similar design propellers are used for special. Purposes. In a deep tank, push-pull propeller is used in which two or more propellers may be attached to the same shaft. These work in opposite directions to create a zone of high turbulence. (The size of the propeller. Is small, i.e., the ratio of diameters between propeller and container o 20 is Sufficient to low viscous liquids. However, for large tanks the maximum size of 0.5 meters propeller is used. Small propellers turn at full motor speed up to 8000 revolutions per minute

The propeller produces axial(longitudinal) movement of the liquid. The flow Currents leaving the propeller continue through the liquid in a given direction until deflected by the floor or wall of the tank.

**Uses:** Propellers are used when high mixing capacity is needed. These are effective in handling liquids having a maximum viscosity of about 2.0pascals second and slurries up to 10% solids of fine mesh size. They can be used upte3.5 metre cube (or 3500 litres). Effective gas- liquid dispersion is possible at the laboratory scale. Multivitamin elixir, disinfectant solutions are manufactured using propellers.

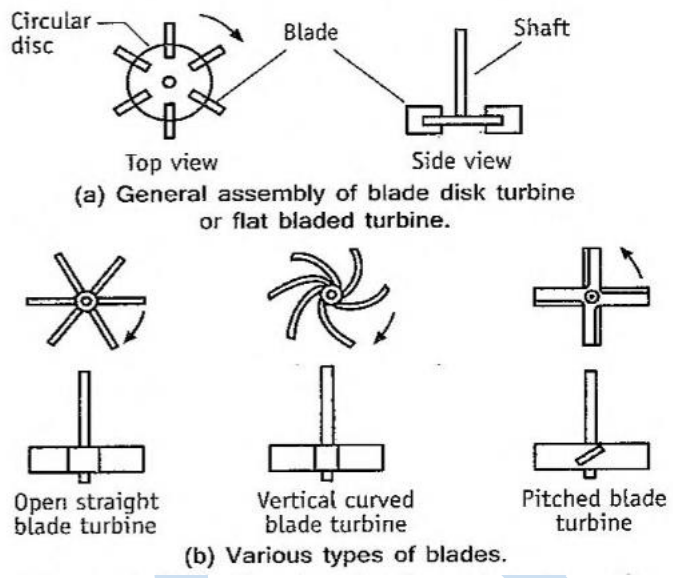
**Disadvantage**: Propellers are not normally effective with liquids of viscosity greater than 5 pascal-second, for example, glycerine, castor oil etc.

## Turbines

A turbine consists of a circular disc to which a number of short blades are attached. The diameter of the turbine ranges from 30-S0 percent of the diameter of the vessel. It rotates at a lower speed than

propeller (50-200 revolutions. Per minute). Different forms of turbines are shown in Figure. The blades may be straight, curved, pitched or vertical.

A flat bladed turbine produces radial and tangential low, but as speed increases, radial flow dominates. A pitched blade turbine produces axial flow




Turbine impeller (or mixing clement).

Pitch is defined as the distance the impeller would move through the uid per revolution, if slippage does not occur.

Near the impeller, the zone of rapid currents, high turbulence and intense shear is observed. The shear produced by turbines can be further enhanced using a diffuser ring. A diffuser ring is a stationary perforated

Or slotted ring, which surrounds the turbine. It increases shear forces. The liquid passes through the perforations reducing rotational swirling and vertexing.

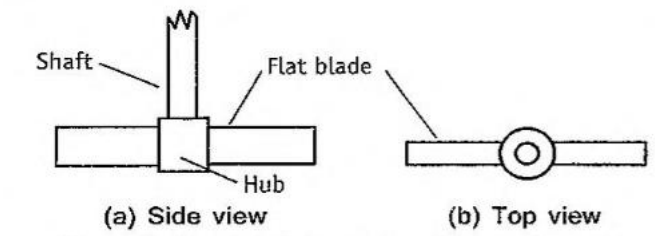
**Uses:** Turbines are effective for high viscous solutions with a very wide range of viscosities up to 7000-pascal seconds. A few examples are syrups, liquid paraffin. Glycerine et. In low viscosity materials of large volumes. Turbines gene rate strong currents (intense shear) which spread throughout the Tank destroying stagnant pockets. They can handle slurries with 60%solids. Turbines are suitable for liquids. of large volume and high viscosity, if the tank is baffled.

**Advantages**: Turbines give greater shearing forces than propellers, though the pumping rate is less. Therefore, turbines are suitable for emulsification.

## Paddles

A paddle consists of a hub centrally with two long flat blades attached to it vertically

Paddles with two blades or four blades are common. Sometimes, the blades arc pitched. In some paddles, the blades are dished or hemi- spherical in shape and have a large surface area in relation to the tank in which they are used. Because of this shape, paddles pass close to the tank walls and effectively mix viscous liquids, avoiding dead spots and deposited solids.




(a) Side view (b) Top view. Paddle type of agitator or impeller

A shaft carry Ing hub-blades rotates at a low speed of the order of I00 revolutions-per minute. They Push the liquid radially and tangentially with almost no axial motion unless the blades are pitched. In deep tanks several paddles are attached one above the other on the same shaft. At very low speeds it gives mild agitation in an unbaffled tank, whereas for higher speeds baffles are necessary. Otherwise, the liquid is swirled around the vessel with little mixing.

**Uses**: Paddles are, used in the manufacture of antacid suspensions (aluminium hydroxide gel and magnesium hydroxide), agar and pectin Related purgatives, antidiarrheal mixtures such as bismuth-kaolin.

**Advantage**: Vortex formation is not possible with paddle impellers because of low-speed mixing.

**Disadvantage**: Mixing of the suspension is poor, therefore, baffled tanks are required.

## MIXING OF IMMISCIBLE LIQUIDS

### Equipment

Mixing of immiscible liquids is carried in pharmacy mainly in the manufacturing of emulsions. The equipment used for the preparation of an emulsion is Known as emulsifier Generally a fine emulsion can be obtained and, therefore, equipment is also known.as homogenizer

Fine emulsion is prepared in two stages. In the first stage, coarse emulsion is prepared by using one of the following.

- Wedge wood
- porcelain mortar and pestle
- mechanical blender
- milk-shake mixer
- Hand homogenizer
- propeller in a baffled tank.

Sometimes, the above equipment directly gives fine emulsion. Otherwise, coarse emulsion is subjected to homogenization in the second stage to get fine emulsion by using one of the following

- Silverson emulsifier
- Colloid mil
- Rapisonic homogenizer

Hence this equipment is also known as *homogenizers*.

**EQUIPMENT**

**Factors Influencing the Selection of an Emulsifier**

**Quantity of emulsion to be Prepared**: Batch wise. Or continuous operation.

**Flow properties of liquids:** Newtonian, plastic, pseudoplastic or Dilatant.

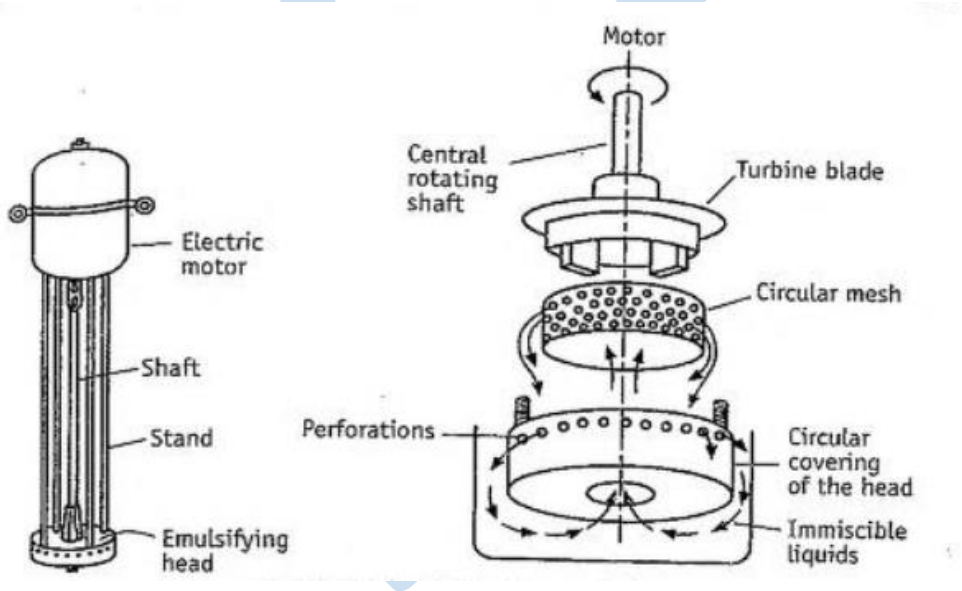
**Temperature maintenance**: Mixing will be effective at high temperatures provided the material is stable.

**Desired rate of cooling:** if elevated temperatures are applied.

**SILVERSON MIXER—EMULSIFIER**

**Principle**: Silverson mixer-emulsifier produces intense shearing forces and turbulence by the use of high speed5 rotors. This turbulence causes the liquids to pass through fine interstices formed by closely placed perforated metal sheets. Circulation of material takes place through the head by the suction produced in the inlet at the bottom of the head. Circulation of the material ensures rapid breakdown of the dispersed liquid into smaller globules

**Construction** The construction of a Severson emulsifier is shown in the Figure. It consists of long supporting columns connected to a motor which give support to the head. The central portion contains a shaft. One end of which is connected to the motor aid the other end is connected to the head. The head carries turbine blades. The blades are surrounded by a mesh, which is further enclosed by a cover having openings:




Construction of Silverson emulsifier.

**Working**: The emulsifier head is placed in the vessel containing immiscible liquids (or coarse emulsion) in such a way that it should get completely dipped in the liquid. When the motor is started, the centra 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 centre of the base and subjected to intense mixing action. Centrifugal forces expect the contents of the head with great force through the mesh and onto the cover (Figure b). As a result, a fine emulsion emerges through the openings of the outer cover The intake and expulsion of the mixture set up a pattern of circulation to ensure rapid breakdown of the bigger globules into smaller globules.

**Uses**: Silverson mixer is used for the preparation of emulsions and creams of fine particle size.

**Advantages**: (1) Silverson mixer is available in different sizes to handle the liquids ranging from a few millilitres to several thousand litres.

(2) It can be used for batch operations. It is also used for continuous operation by incorporating into a pipeline, through which the immiscible liquids flow.

**Disadvantage**: Occasionally. There is a chance of clogging of pores of the mesh.

## MIXING OF SEMISOLIDSs

### Equipment

Semisolid dosage forms include ointments, pastes, creams, jellies etc. While mixing such dosage forms, the material must be brought to the agitator or the agitator must move the material throughout the mixer. The mixing action includes-combination of low-speed shear-smearing, wiping folding, stretching and compressing. A large amount of mechanical energy is applied to the material by moving parts. Sometimes. A part of the supplied energy, appears as heat. The forces required for efficient mixing are high and consumption of power is also high. Hence, the equipment must be ruggedly constructed to tolerate these forces. Mixing equipment are. Also used for preparing tooth-pastes, pill masses and wet mass for granulation.

Some semisolids exhibit dilatant property, i.e., viscosity increases with increase in shear rates. Therefore, mixing must be done at lower speeds. The speed must. Be changed accordingly to thixotropic, plastic and pseudoplastic materials.

**Classification of Equipment**

*Agitator mixers*: Examples are sigma mixer and planetary mixer.

*Shear mixers*: Examples are triple roller mill and colloidal mill.

**Selection of Mixing Equipment, for Semisolids** (Physical properties of the materials density, viscosity and miscibility.

**Economic considerations** regarding processing time required for mixing and power consumption.

The **cost** of equipment and its maintenance.

### Mechanism of Semisolids Mixing

The mechanisms involved in mixing semi-solids depend on the properties of the material which generally may show considerable variations. Many semi-solids form neutral mixtures having no tendency to segregate although sedimentation may occur. The three most commonly used semi-solid mixers are:

**(i) Sigma blade mixer**: This mixer has two blades that operate in a mixing vessel that has a double trough shape. These blades move at different speeds towards each other. It can be used for products like granulation of wet masses and ointments.

**(ii) Triple-roller mill**: The triple roller has differential speed and narrow clearance between the rollers which develops a high shear over small volumes of semi-solid material. This type of mill is generally used to grind semisolids to achieve complete homogeneity in the material, for example, ointments.

**(iii) Planetary mixer:** In the mixer, the mixing arm rotates around its own axis and around a common axis typically the mixing wheel itself. Kneading is provided by the blades, while shearing is accomplished by the narrow passage between them and the wall of the can

**MCQ Each carry 1 mark**

1. Mechanism of mixing in silverson mixer is:
    a) Connective
    b) laminar
    c) Random
    **d) Turbulent**
2. Mixing of semisolids is carried out using
    a) Double cone mixer
    **b) Planetary mixer**
    c) Rotating cube mixer
    d) Fluidized bed mixer
3. Flow pattern in axil and tangential in
    a) Propellers
    b) Turbines
    c) Paddles
    **d) All of the above**

**Each carry 2 marks**

1. Suggest suitable mixing equipment for semisolids.
2. Describe the different factors influencing the selection of an emulsifies

**Each carry 5 marks**

1. Describe the construction and working of a Silverson mixer-emulsifier with the help of a neat diagram
2. Describe the different type of impellers used for mixing

**Each carry 10 marks**

1. With a neat sketch describe the construction and working of equipment for mixing pastes and plastic masses. What are their pharmaceutical applications?

**MCQ Each carry 1 mark**

1. Which of the following produces randomization during the Mixing operation?
    a. Dissimilar charges
    b. Dissimilar forces
    c. Dissimilar ions
    **d. Dissimilar particles**
2. Which of the following forces aids the tumbling action for promoting inter-particle movement?

a. Electrostatic force
**b. Gravitational force**
c. Surface force
d. Van der Walls force

3. Which one of the following rates (kinetic orders) is observed in the mixing of solids?
**a. First order**
b. Pseudo-first order
c. Second-order
d. Zero order
4. Which type of particle-particle interactions is experienced on account of surface charges produced during mixing?
a. Attraction
b. Collisions
c. Diffusion
**d. Repulsion**
5. Which one of the following is NOT an example for inertial forces?
a. Electrostatic forces
b. London forces
**c. Surface forces**
d. Van der Waals forces
6. In dispensing, which one of the following terms is NOT used for mixing?
**a. Sizing**
b. Spatulation
c. Trituration
d. Tumbling
7. Degree of mixing is also known as:
   **a. Degree of Homogeneity**
   b. Extent of mixing
   c. Ordered Mixing
   d. Random Mixing
8. Which type of mixture is easily formed?
   **a. Positive**
   b. Negative
   c. Neutral
   d. Ampholytic
9. Mechanism not used in solid-solid Mixing:
   a. Connective
   b. Shear Mixing
   c. Diffusion
   **d. Tumbling**

**Each carry 2 marks**

1. Define and differentiate mixing and agitation.
2. What are the factors affecting selection of a mixer?
3. Give the applications of mixing

**Each carry 5 marks**

1. Differentiate solid and liquid mixing
2. Write about statistical Evaluation Procedure for the Blending or Mixing of Powders

Write about the factors influencing mixing