UNIT: III **(MIXING)**

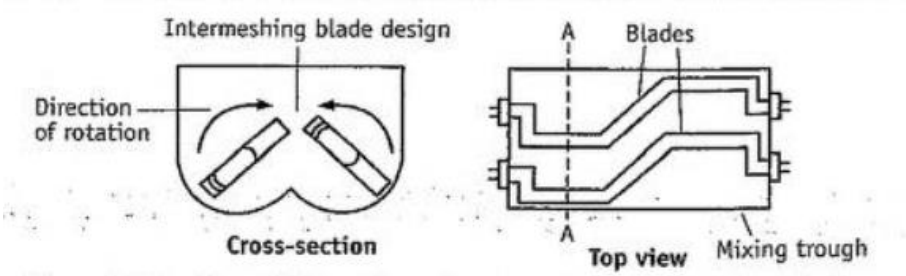
CLASS:27

TOPIC: PRINCIPAL, CONSTRUCTION, WORKING, USES, MERITS AND DEMERITS OF SIGMA BLADE MIXERS, PLANATERY MIXERS

SIGMA BLADE MIXER

Principle: The mechanism of mixing is shearing. The inter-meshing of sigma shaped blades creates high shear and kneading actions. Convective mining is achieved by cascading the material.

Construction: The construction of a sigma blade blender is shown in Figure It consists of double trough shaped stationary bowl. Two sigma (indicating the shape of the Greek letter) shaped blades are fitted horizontally in each trough of, the bowl. These are connected to a fixed speed drive. The mixer is loaded from the top and unloaded by tilting the entire bowl by means of a rack-and-pinion drive.



Sigma blade mixer. Stationary shell and rotating blades.

Working: Different powders are introduced from the top of the trough. The body is covered because considerable dust may be evolved during dry blending and granulating solution may evaporate during wet granulation.

Through the fixed speed drive. The sigma blades are allowed to rotate. The blades move at different speeds. One usually about twice the speed of other, resulting in lateral pulling of the material. They turn towards each other so that the powders move from the sides to the centre of the bowl. The material further moves from the top to downwards over the point and then sheared between the blades and the wall of the trough. Thus, cascading action (convective) as well as shear action can be achieved. The perforated blades help in breaking lumps and aggregates. Thus, high shear forces are set up. The final stage of mix represents an equilibrium state. The operating conditions of a given mixer can markedly affect the steady state and thus the quality of the mixing. By means of a rack-and-pinion drive the bowl is tilted to empty the blend.

Uses: Sigma blade mixer is commonly used for mixing of dough ingredients in the baking industry. It is used in wet granulation process in the manufacture of tablets, pill masses and ointments. It is primarily used for liquid-solid mixing. Although it can be used for solid-solid mixing

Advantages:

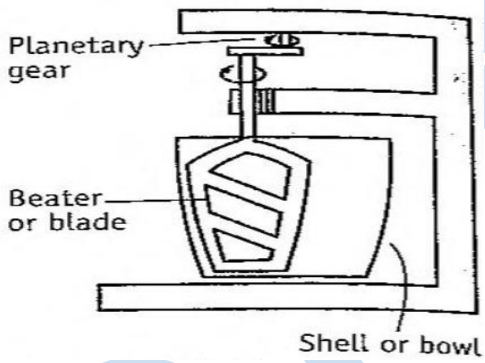
1. Sigma blade mixer creates a minimum dead space during mixing
2. At has close tolerances between the blades and the side-walls as, well as bottom of the mixer shell.

Disadvantage: Sigma blade mixer works at a fixed speed.

PLANETARY MIXER

Principle: In a planetary mixer. The blade tears the mass apart and shear, is applied between a moving blade and a stationary wall. The missing arm moves in two ways, around its own axis and around. The central axis, so that it reaches every spot of the vessel. The plates in the blade are sloped so that the powder makes an upward movement. Therefore: tumbling (convective). Motion is also obtained.

Construction: The construction of a planetary mixer is shown in figure. It consists of a vertical cylindrical shell, which can be removed ither by lowering it beneath the blade or raising the blade above the bowl. The mixing blade is mounted from the top of the bowl. The mixing shaft is driven by a planetary gear train. As indicated in the Figure. It rotates around the ring gear, which further rotates round the mixer blade. It is normally built with a variable speed drive.



planetary mixer

Working: In the planetary mixer. The agitator has a planetary motion. It rotates on its own, and around the central axis so that it reaches all parts of the vessel. Beater is shaped to pass with close clearance over the side and bottom of the mixing bowl. Therefore, literally there are no dead spaces in the mixing bowl. The blade tears the mass apart and. Shear is applied between the moving blade and the stationary wall. The plates in the blade are sloped so that the. Powder makes an upward movement. Therefore. Tumbling (convective) motion -is also obtained. Since it is a variable speed driven. Initially the blade moves slowly for premixing and finally at increased speed for active mixing. Thus, high shear can be applied for mixing. Emptying he bowl may be done by hand (scooping) or by dumping mechanism.

Uses: Planetary mixer produces precise blends in addition to breaking down of agglomerates rapidly. Low speeds are used for dry blending and faster speeds for the kneading action required in wet granulation. Steam jacketed bowls are used in. the manufacture of sustained release products and ointments.

Advantages: Speed of the rotation can be varied at will. So, it is advantageous over sigma blade or ribbon type blenders. This is more useful for wet granulation process. There are no packing glands in contact with the product.

Disadvantages:

(1) Mechanical heat is built up within the powder mix.
(2) It requires high power.
(3) It has limited size and is useful for batch work only

MIXING OF LIQUIDS

Liquid-liquid mixing is considered as a simple operation compared to that of solid-liquid mixing. At involves the formation of a homogeneous system. Similar to solid-solid mixing, fluid (or liquid) mixing also involves the application of shear. Agitation and mixing are not synonymous.

Agitation refers to the induced motion of a material in a specified way. Usually in a circulatory pattern. Inside a container.

Mixing refers to the random distribution into or through one another of two or more separate phases

The nature of liquids mainly determines the ease of mixing According to theories of solutions, liquid mixtures are classified as follows.,

1. **Miscible liquids** These are miscible in all proportions. For example, ethyl alcohol and water. Are miscible in all proportions. These liquids can be mixed easily by employing the mechanisms of bulk transport and shear. Cosmetics (after-shave lotion). Elixirs etc., belong to this class.

2. **Partially miscible liquids**: These are miscible in. one-another at one particular proportion. Their miscibility depends on temperature and pressure: For example, p-cresol and water. are miscible in a certain proportion. Mixing poses certain difficulties in the preparation of disinfectant solutions.

3. Immiscible liquids: As the name indicates, these are not miscible. For example, vegetable oils and water are not miscible or their miscibility is very- low. Normally, they form emulsions. Mixing of these liquids is very difficult. A homogeneous dispersion may b obtained by adding emulsifying agents. Mixing them requires high shear.

The mixing of immiscible liquids is discussed as a separate section. In pharmacy, one of the liquids normally used is water. A number of solid and liquid ingredients are added in the formulation of dosage forms. Based on the shear stress-shear rate relationship, fluids are classified as Newtonian and non-Newtonian systems.

Applications of Liquid Mixing

Liquid mixing promotes heat transfer between liquid and a heating source. This step is essential in the crystallization of drug substances. Uniform heat transfer in the solution yields crystals of same size. For example, agitated batch crystallizer works on this principle. Liquid mixing process is essential in the manufacture of a number of dosage forms. Some of them are listed below.

Preparations	*Phases mixing*	*Examples*
Suspensions	Solid-liquid	Calamine lotion
Emulsions	Liquid-liquid (immiscible)	Benzyl benzoate emulsion
Solutions	Soluble solid-liquid	B Complex elixir
Solutions	Soluble liquid-liquid	Alcohol-water (elixir) Chloroform-water (preservative)
Aerosols	Liquid-gas	Salbutamol inhaler

MECHANISMS OF MIXING

The mechanisms of liquid mixing can be studied under four classes. They are

Bulk transport

Turbulent mixing

Laminar mixing

Molecular diffusion

Bulk Transport

Bulk transport is defined as the movement of a large portion of a material from one location to another location in a given system.

For this purpose, mixing devices such as rotating blades and paddles are used, which moves the material in different directions.

Turbulent Mixing

Turbulent mixing is defined as mixing due to turbulent flow, which results in random fluctuation of the fluid velocity at any, given point within the systemin the turbulent flow, fluid velocity at a given point fluctuates continuously in three directions, x, y and z However, the Liquid moves in one direction depending on the dominant component. In general, the liquid has different velocities at different locations at the same tine.

Turbulent flow is a highly effective mechanism for mixing. Turbulent flow can be seen as a composite of eddies of various sizes. An **eddy** is defined as a portion of fluid moving as a unit in a direction. Large eddies tend to break up forming eddies of smaller size, until they are no longer distinguishable. An additional characteristic of turbulent flow is its intensity, which is related to the velocities with which eddies move.

Laminar Mixing

Laminar mixing is the mixing of two dissimilar liquids through laminar flow, i.e., the applied shear stretches the interface between them. In this mechanism, layers fold back upon themselves. Thus, the number of layers Increases Hence, the interfacial area between them also increases exponentially with time. Mixing may also result in simple stretching of the fluid layers without any significant folding action. This Is also suitable for liquids, which require moderate mixing.

Molecular Diffusion

Molecular diffusion is the mixing at molecular level in which molecules diffuse due to thermal motion.

Molecular diffusion is explained by the Fick's law, which depends on the concentration gradient at different regions. The concentration gradient decreases with time and it reaches zero when mixing is completed i.e., equilibrium condition. When molecular diffusion and laminar flow occur simultaneously, molecular diffusion reduces the sharp discontinuities at the interface between the two layers

Simultaneously more than one mechanism may operate during mixing.

MCQ Each carry 1 mark

1. Sigma blade mixers are commonly used in

a) **Wet granulation**
b) Crude fibre mixture
c) Dry granulation
d) Powder mixture

2. Which type of action is required for wet granulation, when planetary mixer is used?
   a) Agitator action
   b) Blending action
   c) Kneading action
   d) none of the above
3. Which of the following are the advantages of using planetary mixer?
   a) **Proper mixing is guaranteed.**
   b) Higher densities of the product can be developed by using it.
   c) It only requires low maintenance.
   d) It reduces manual labour and prolonged mixing time for other types of mixers.
4. In planetary mixer, the shear is applied between
   a) **Moving blade and and stationary wall**
   b) Stationary blade and moving wall
   c) Both of these
   d) None of these
5. The mechanisms of liquid mixing can be studied under four classes. They are
   a) Bulk transport
   b) Turbulent mixing
   c) Laminar mixing
   d) Molecular diffusion
   e) All of the above

Each carry 2 marks

1. Write the uses of the sigma blade blender.
2. Classify liquids based on their miscibility. Give one example in each Case.
3. Enumerate the applications of liquid mixing.

Each carry 5 marks

1. Describe the mechanisms of liquid mixing.
2. Explain the factors influencing mixing of solids. Write the principle of planetary mixer

Each carry 10 marks

1. Write in detail about sigma blade blender and planetary mixer