

# MIXING AND HOMOGENIZATION

- ✘ MIXING is defined as the unit operation that combines two or more components together by agitation, shear or mixers. The final product of mixture contains uniform distribution of both components of mixture.
- ✘ Example of mixers: Blenders, Planetary mixtures, Propellers etc.



# ADVANTAGES/APPLICATIONS OF MIXING

- ✘ To obtain uniform composition of the mixed components.
- ✘ To enhance physical & chemical reaction of mixed components.
- ✘ To improve dissolution & diffusion of mixture.
- ✘ To get true solution after mixing two miscible liquids.

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- ✘ Mixing is essential to produce emulsion when two immiscible liquids are mixed together with emulsifying agent.
  - ✘ To produce a solution after mixing a solid with liquid.
  - ✘ To produce semisolid products like ointments, suppository after mixing a solid or liquid with semisolid base.
  - ✘ Mixing is essential in manufacturing of tablets & capsules to get proper mixture of solid powders.

# TYPES OF MIXTURES

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## ✘ Positive mixtures

Mixtures formed from two or more miscible liquids or gases through diffusion process are positive mixtures. Such mixtures requires no energy & creates no problem. e.g: solution, syrup, etc

## ✘ Negative mixtures

Mixtures formed from immiscible components like solid & liquid to form suspension or emulsion are negative mixtures. Such mixtures require more energy & may separate out. e.g: suspension, emulsion, etc

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## × Neutral mixtures

Mixtures formed from different components like solid & liquid to form static mixtures are neutral mixtures. Such mixtures do not easily mix but once mixed they do not separate easily. e.g: paste, ointments, etc

# LIQUID MIXING

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Liquid mixing is divided into following subgroup:

1. Mixing of liquid and liquid
  - i. Mixing of two or more miscible liquids
  - ii. Mixing of two or more immiscible liquids
2. Mixing of liquid & solid
  - i. Mixing of liquids & soluble solids
  - ii. Mixing of liquids & insoluble solids

# MECHANISM OF MIXING

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- × Bulk Transport
- × Laminar Mixing
- × Turbulent Mixing
- × Molecular Diffusion

# LIQUID MIXERS

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- ✘ Shaker Mixers
- ✘ Propeller Mixers
- ✘ Turbine Mixers
- ✘ Paddle Mixers



**SHAKER MIXER**

# PROPELLER MIXERS



Marine Propeller mixer



Clamp mounted portable mixer



# Turbine mixers

- The most versatile of all mixers in the entire span of mixing equipments are the axial and radial flow turbines
- Turbines mixers can be made to handle huge batches, even upto 5,00,00gal & suitable for emulsification process.



**Radial Flow turbine**



**Axial flow turbine**

# PADDLE MIXER



# SOLID MIXING

## MECHANISM OF SOLID MIXING:

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- ✘ **Convective Mixing:** Mixing of the bulk particles as a whole from one container to another. Also known as bulk transport.
- ✘ **Shear Mixing:** Mixing of particles using shear forces by agitator or stream of air.
- ✘ **Diffusive Mixing:** Mixing of materials by random movement of particles along its different layers through diffusion process.

# PROCESS OF MIXING

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1. Expansion of solid bed occurs so the mixing equipment should be filled about 60% of its volume.
2. Application of 3-Dimensional shear forces.
3. Mixing time should be optimum to prevent aggregation & separation of particles.
4. Avoid demixing due to particle breakdown.

# FACTORS AFFECTING MIXING OF SOLID PARTICLES:

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1. Particle size
2. Particle shape
3. Density
4. Porosity
5. Volume
6. Flow properties & charge
7. Mixing mechanism
8. Mixing time
9. Surface area

# SEMISOLID MIXING

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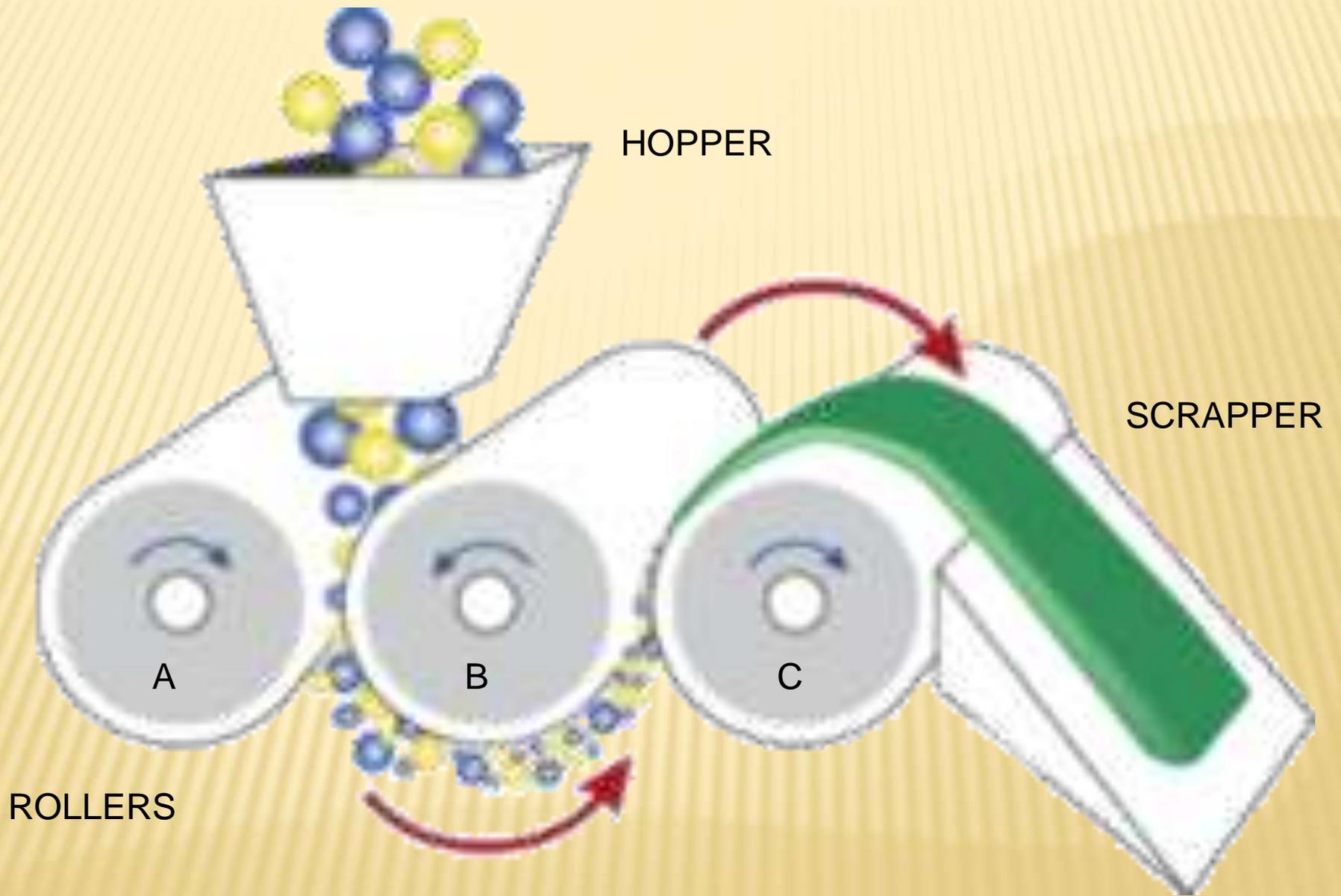
- ✘ Mixing of liquid with semi-solid
- ✘ Mixing of solid with semi-solid
- ✘ Semisolid mixing involves dispersion of liquid or solid materials in the semi-solid base. They are neutral mixtures that do not separate out easily. Miscible liquid & soluble solid are easily mixed with low force & short time. However, immiscible liquids & insoluble solids are mixed with help of emulsifying agent or wetting agent.
- ✘ Semisolid mixing equipments: Ribbon blender, Triple roller mill, Planetary mixture, Colloid mill, etc.

# MIXING EQUIPMENTS

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## 1. TRIPLE ROLLER MILL

Triple roller mill consists of 3 horizontal rollers which moves at different speeds. There is very small gap between rollers which can be adjusted according to the need. Materials coming between rollers is crushed, depending upon the gap & also sheared by the difference in rate of movement between two surfaces. The size reduction is due to attrition & this method is effective for dispersions of solid in semi-



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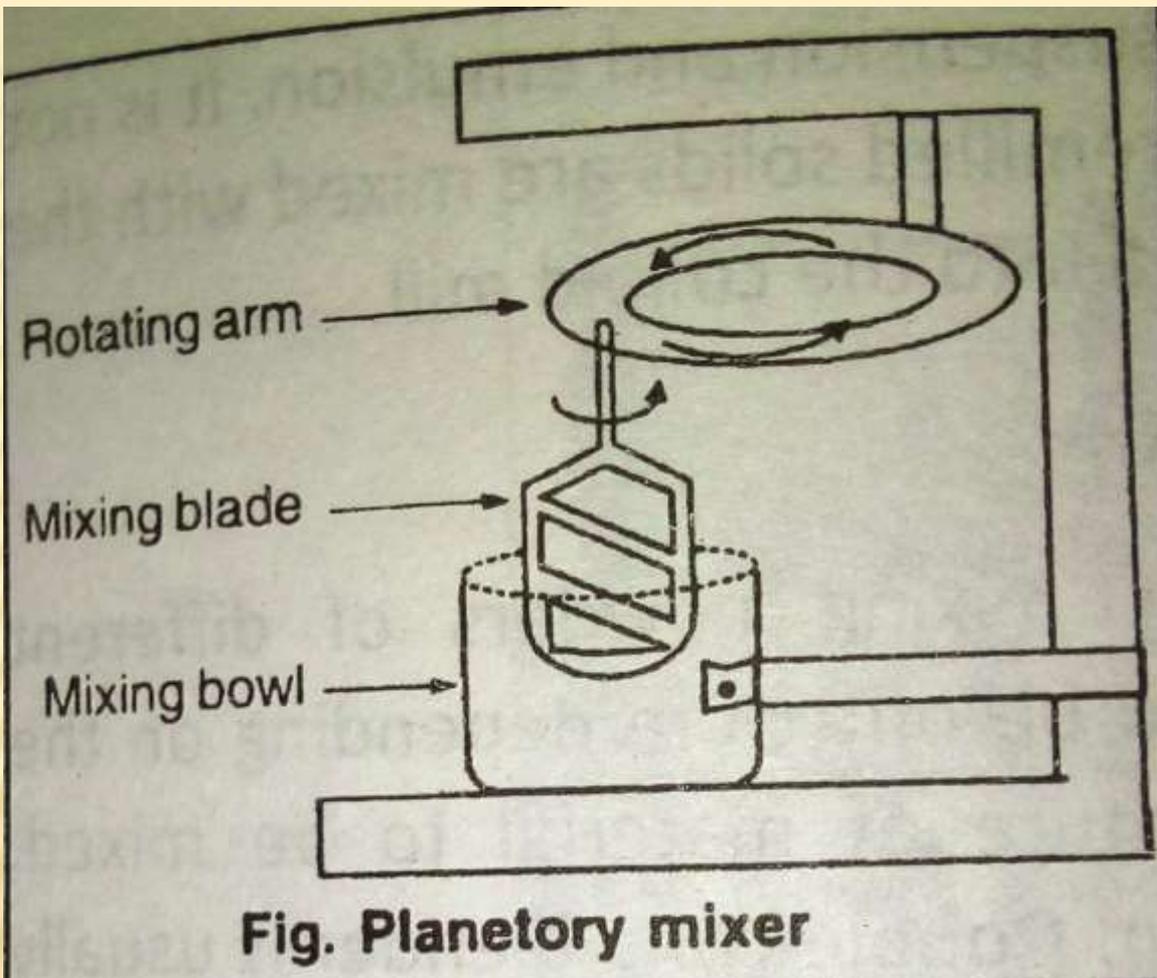
The material is fed through the hopper into roller A & B where they are crushed or dispersed. Then they are passed to roller B & C where they are further crushed & smooth mixture is formed. Finally the mixture is removed by the scrapper from the rollers.

Uses: Semi-solid mixing, solid mixing

## 2. PLANETARY MIXER

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Planetary mixer consists of rotating arm & mixing arm attached to a stationery wall. Mixing arm consists of mixing blades attached to it which moves around its own axis & also moves around central axis. This makes mixing of material in every part of the mixing vessel. The rotation of mixer is similar to rotation of planets in its own axis & also around the sun as central axis. It is used in mixing of solids & semisolids



**USES:** Semi-solid mixing, solid mixing, granulation, etc.



### 3. DOUBLE CONE MIXER/ BLENDER

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- ✘ It consists of large double cone shaped tank used for mixing solid powders with different densities. Mixing occurs by the rotation of blender usually at 30 to 100 rpm. The solid powders are fed & discharged from same opening/port. Mixing is very efficient in blenders because of optimum rotation of powders with different densities.
- ✘ Some blender consists of cylindrical tank with mixing blades attached to a shaft along the axis of the tank. These blades helps to split powders & mix efficiently.



V blender



Double cone blender



Octagonal blender

USES: SOLID MIXING, POWDER MIXING

## 4. COLLOID MILL

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- ✘ Colloid mill consists of a conical rotor and stator. The distance between rotor and stator is adjusted between 0.005 to 0.075 cm. The rotor is connected to a high speed motor which can revolve at a speed of 3000 to 20000 rpm.
- ✘ The fine material (premilled) is feed to hopper and size of material is reduced as it passes through moving rotor and stator. It works on the principle of shearing.
- ✘ It is used in the dispersion of suspension &



PHOTO CREDIT: AGILE MACHINERIES PVT. LTD., AND GLOBECORE

USES: LIQUID MIXING (SUSPENSION, EMULSION), SEMISOLID MIXING

# HOMOGENIZATION

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- ✘ Homogenization is the process of converting non-uniform mixture to a colloidal state or a uniform mixture. It is done by reducing particle size of mixtures or uniform dispersion of the mixtures making the product homogenous.
- ✘ e.g: converting coarse emulsion to colloidal emulsion
- ✘ Homogenizers are used for the preparation of biphasic systems like suspensions, emulsions etc.

# HOMOGENIZERS

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- ✘ **Modified Turbines:** It consists of turbine & stator at a certain distance in the mixer. The rotation of turbines at very high speed creates a pressure difference & reduces the particle size. The particles & fluids pass through the stator & turbines which produces mechanical forces to obtain uniform or homogenized mixture.

- ✘ **Pressure Homogenizer:** It consists of high pressure pump fitted to stainless steel fluid tank. The high pressure is responsible for homogenization of solid dispersed in the liquid.
- ✘ **Ultrasonic Homogenizer** is an example of pressure homogenizer where ultrasonic waves (frequency above 20000 Hz) are generated for mixing or uniform dispersion of the mixtures. The ultrasonic waves produces shear effect responsible for size reduction & homogenization. It is used primarily for emulsification