

# Mixing

## Part 2

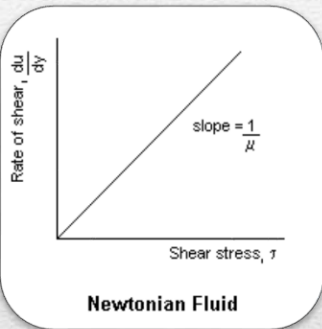
Lab -8-

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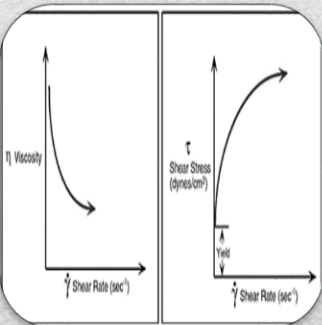
The background of the slide is a light pink color with a dense pattern of small, realistic water droplets. In the center-right area, there is a graphic consisting of a dark red starburst shape with five points. Overlaid on the left side of this starburst is a dark red rectangular box with a white border. Inside this box, the text "FLUID MIXING AND THEIR MECHANISMS." is written in a bold, white, sans-serif font, slanted upwards from left to right.

**FLUID MIXING AND  
THEIR MECHANISMS.**

Depending upon relationship between shear rate and the applied shear stress, the fluids may be divided into



**Newtonian Fluids**



**Non-Newtonian Fluids**

# Liquid mixing mechanisms

Bulk transport

Turbulent flow

Laminar flow

Molecular  
diffusion


- The movement of relatively large portion of material being mixed from one location in the system to another.

- Bulk transport accomplished by means of **paddles**, **revolving blades**, or **other devices** within the mixer arranged so as to move adjacent volumes of fluid in different direction (3D shuffling).

# **1. Bulk transport**

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It is a direct result of turbulent fluid flow which is characterized by a random fluctuation of the fluid velocity at any given point within the system.



In turbulent flow, the fluid has a different instantaneous velocities at different location at same instant in time.



Turbulent flow visualized as (eddies) with various sizes [portion of fluid moving as a unit in a direction contrary to that of general flow]. Larger eddies breakup forming smaller and smaller size eddies until are no longer distinguished.

## **2. Turbulent mixing**

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Streamline or laminar flow is frequently encountered when **highly viscous fluid** are being processed.

occur with gentle stirring and adjacent to stationary surfaces in vessels where turbulent flow is predominant.


when two dissimilar liquids are mixed through laminar flow, the shear generated stretches the interface between them.

### **3. Laminar mixing**

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*Mixing at the molecular level by diffusion resulting from thermal motion of molecules.*



*Occurs in conjugation with laminar flow that tends to reduce sharp discontinuities at the interface between the fluid layers which leads to complete mixing after sufficient time.*

## **4. Molecular diffusion**

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**Equipments**

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graph TD; Equipments --> A["A-Batch mixing"]; Equipments --> B["B-Continuous mixing"]; A --> Impellers; A --> AirStream["Air stream"]; A --> LiquidJet["Liquid jet"];
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**A-Batch  
mixing**

**B-  
Continuous  
mixing**

**Impellers**

**Air stream**

**Liquid jet**

**Equipments**

Mixing is limited  
in volume  
contained in  
suitable mixer

Parts

Tank or  
container

energy  
supplier

Also used to direct  
the flow within  
vessel like baffles,  
Vaness or ducts

Impellers

Air stream

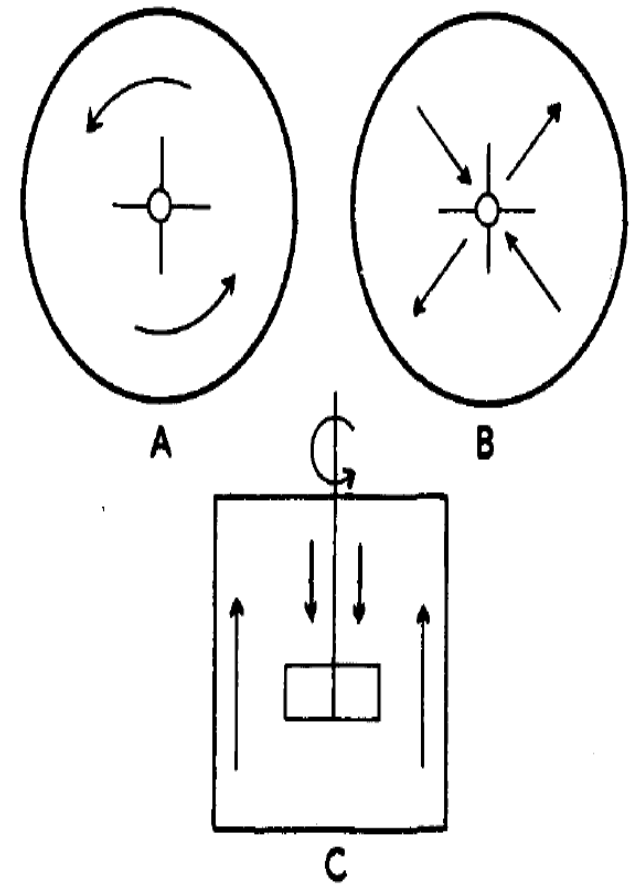
Liquid jet

# A. Batch Mixing

# Types of impeller depend on

**1- Type of flow (radial, axial, tangential)**

**2- Shape and pitch of blades**



*A and B, Diagrammatic representation of cylindrical tanks in which tangential and radial flow occur, respectively. C, Side view of a similar tank in which axial flow occurs.*

# Impeller types

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# Propellers

- Produce flow parallel to their **axis**.
- High efficient with **low viscosity liquids**

# Turbine

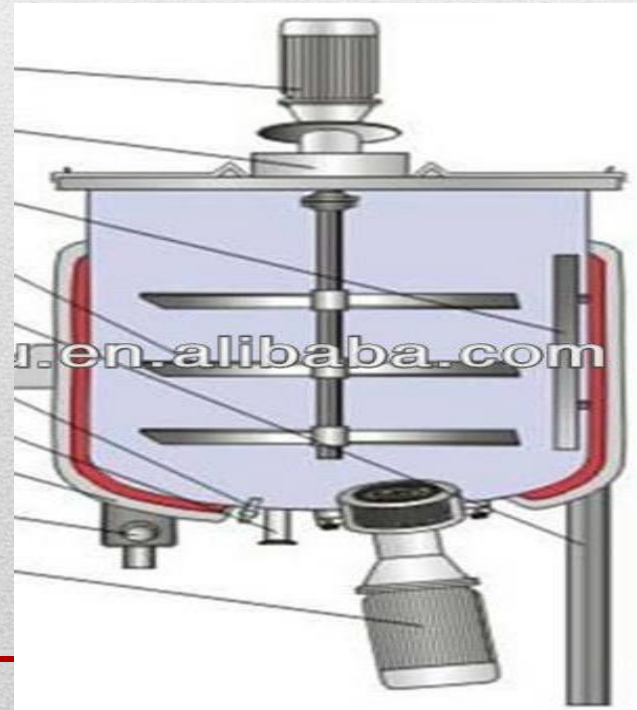
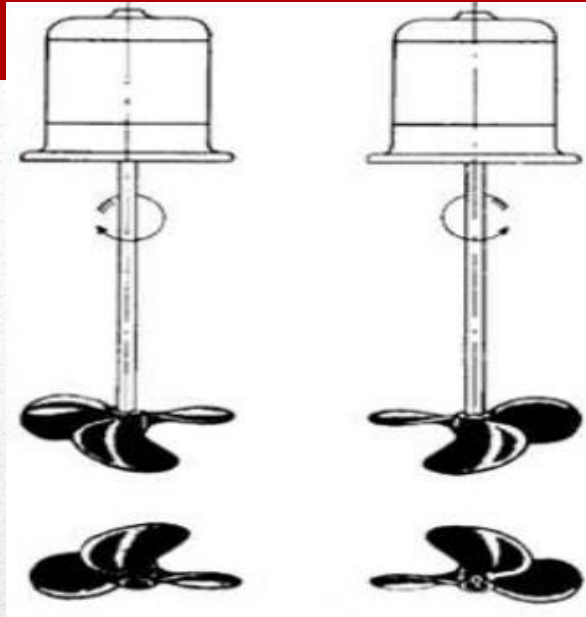
- Produce **axial or tangential** flow or combination
- Blades have constant pitch throughout their length and used for **very viscous liquids**.

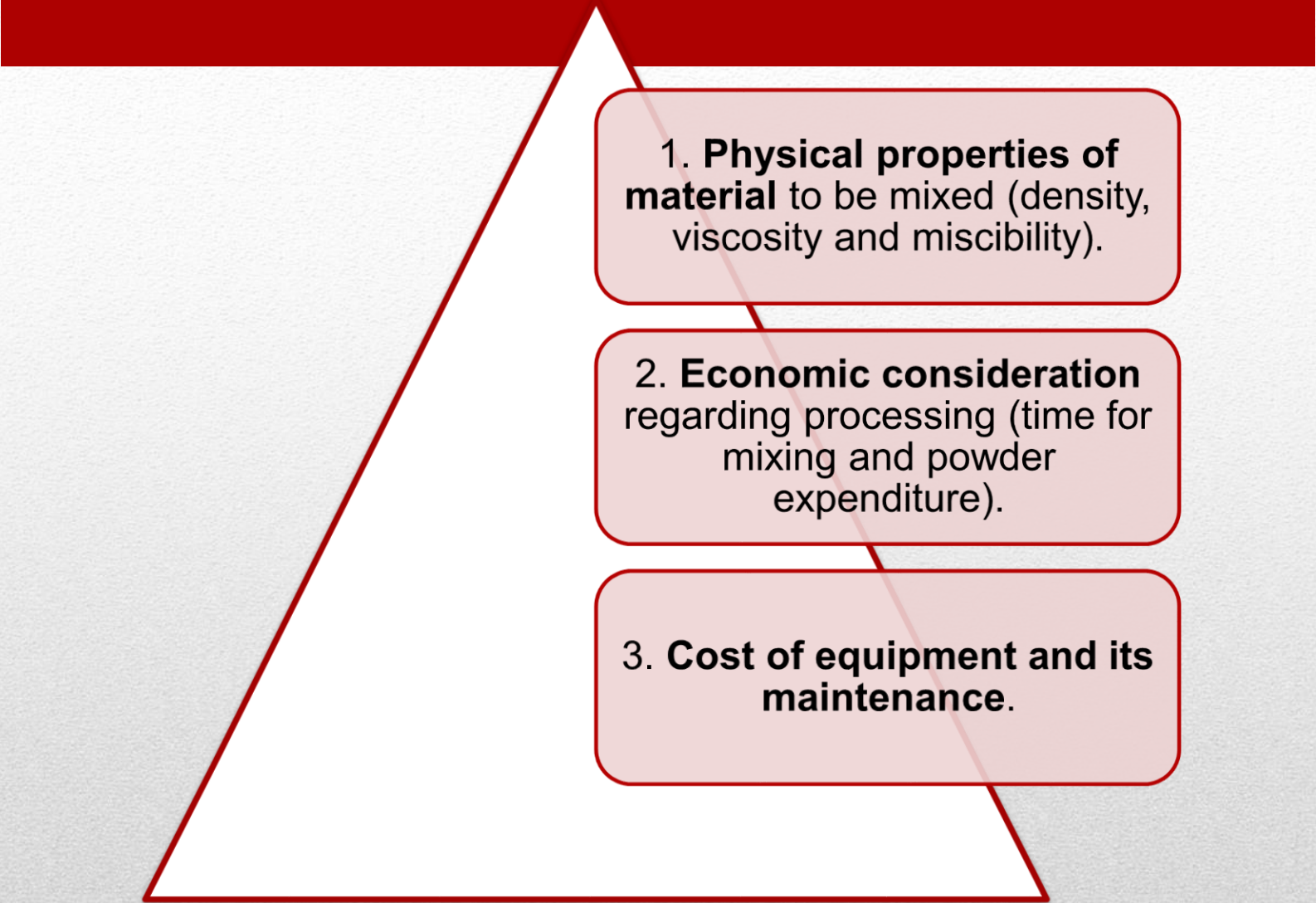
# Paddles

- Circulation is primarily **tangential**.
- Operate at a very low speed and used to mix **low viscosity** liquids and semisolids.

## Impeller types

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1. **Physical properties of material** to be mixed (density, viscosity and miscibility).

2. **Economic consideration** regarding processing (time for mixing and powder expenditure).

3. **Cost of equipment and its maintenance.**

# **Factors affecting mixer selection**

## Liquid –liquid mixing

- Mixing of two immiscible liquids requires subdivision of one of the phases into globules which are then distributed throughout the bulk of the fluid forming a stable emulsion.

## Solid-liquid mixing

- Mixing of finely divided solid with liquid of low viscosity in the production of suspension depends on separation of aggregates into primary particles and the distribution of these particles throughout the fluid.

# Mixers in polyphase systems

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Thank  
you

