Mixing

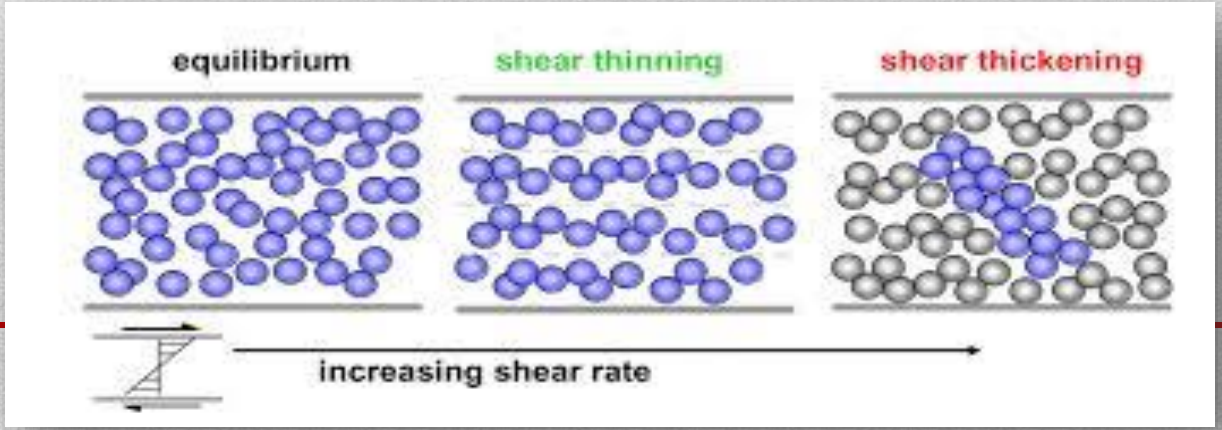
Part 2

Lab -8-

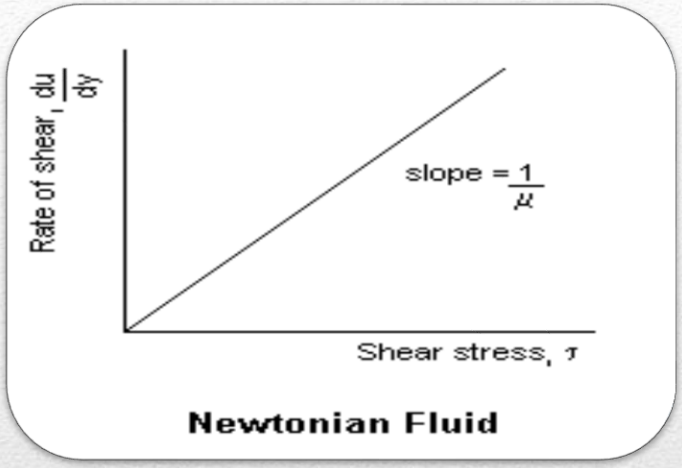
FLUID MIXING AND THEIR MECHANISMS.

Important definitions

- **Shear force:** interactions between moving fluids and the surfaces over which they flow during mixing.
- **Shear rate:** derivative of velocity with respect to the distance measured normal to the direction of flow (dv/dx).
- **Viscosity (dynamic):** is the ratio of shear stress to the shear rate.

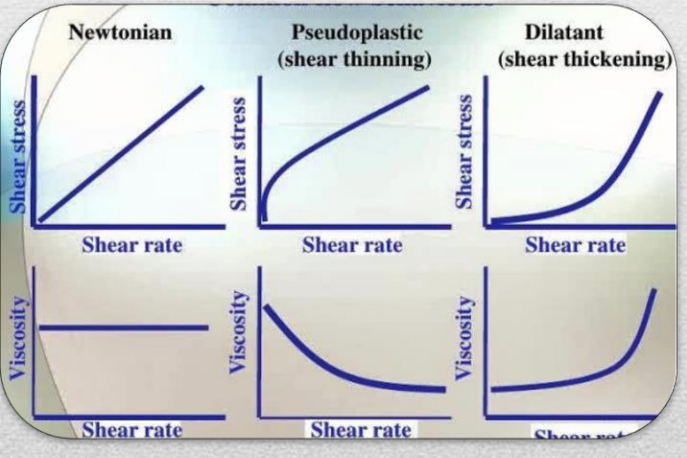


Depending upon relationship between shear rate and the applied shear stress, the fluids may be divided into:



Newtonian Fluids

- Rate of shear is proportional to applied stress.
- Dynamic viscosity is independent of flow rate

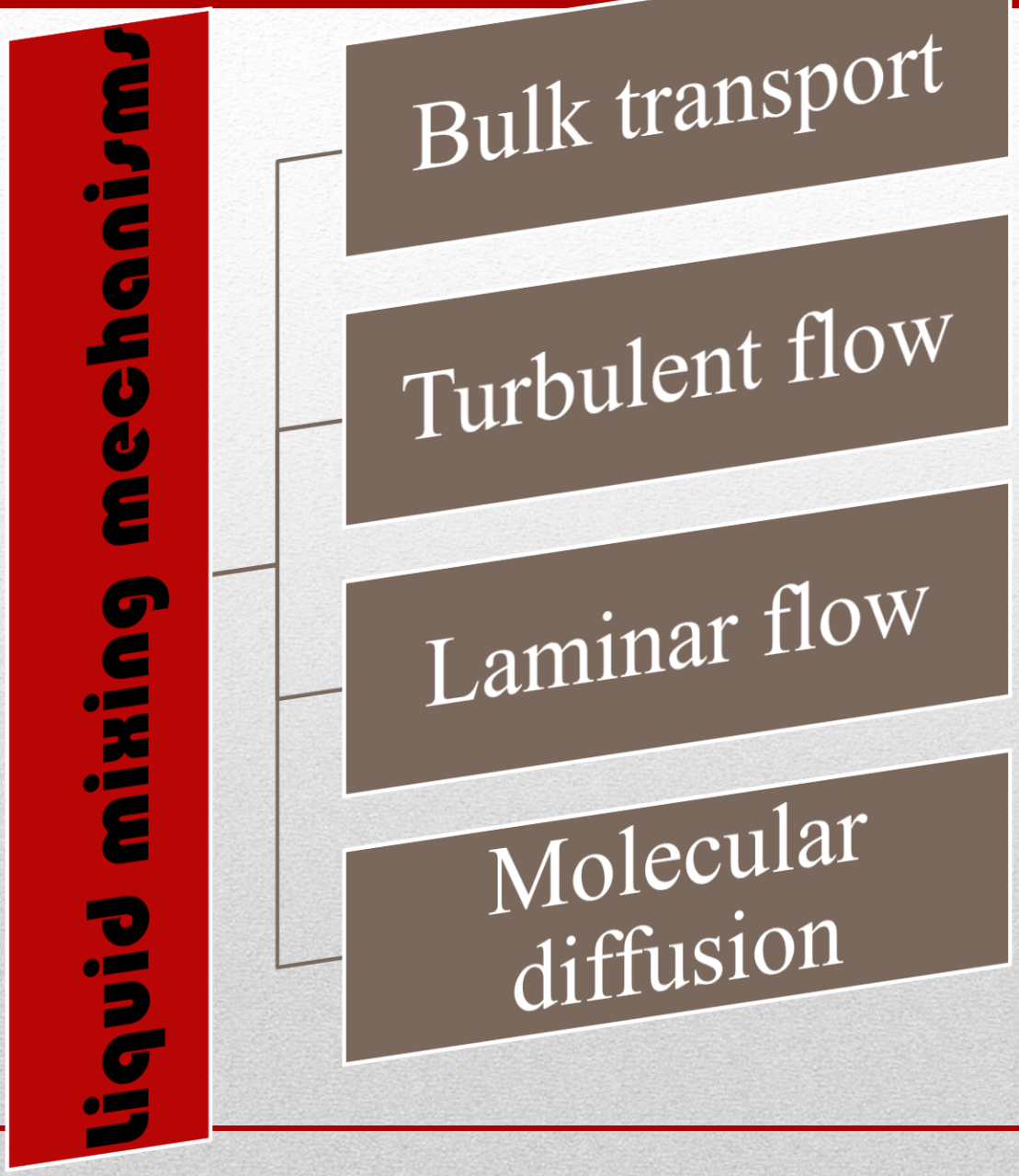


Non-Newtonian Fluids

- Rate of shear is not proportional to applied stress.
- Dynamic viscosity is a function of shear stress.

https://www.youtube.com/watch?v=2ANgoO50_nY

https://www.youtube.com/watch?v=tHX1e-FoUhA


Liquid mixing mechanisms
Bulk transport
Turbulent flow
Laminar flow
Molecular diffusion

1. Bulk transport

- 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).

https://www.youtube.com/watch?v=PwyHWpIS1F8

2. Turbulent mixing

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.

https://www.youtube.com/watch?v=DSYE9jqQScM

3. Laminar mixing

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.

Case: Two dissimilar liquids are mixed through laminar flow

↓

Shear generated and stretches the interface between them.

https://www.youtube.com/watch?v=DHG3f8bWJVw

4. Molecular diffusion

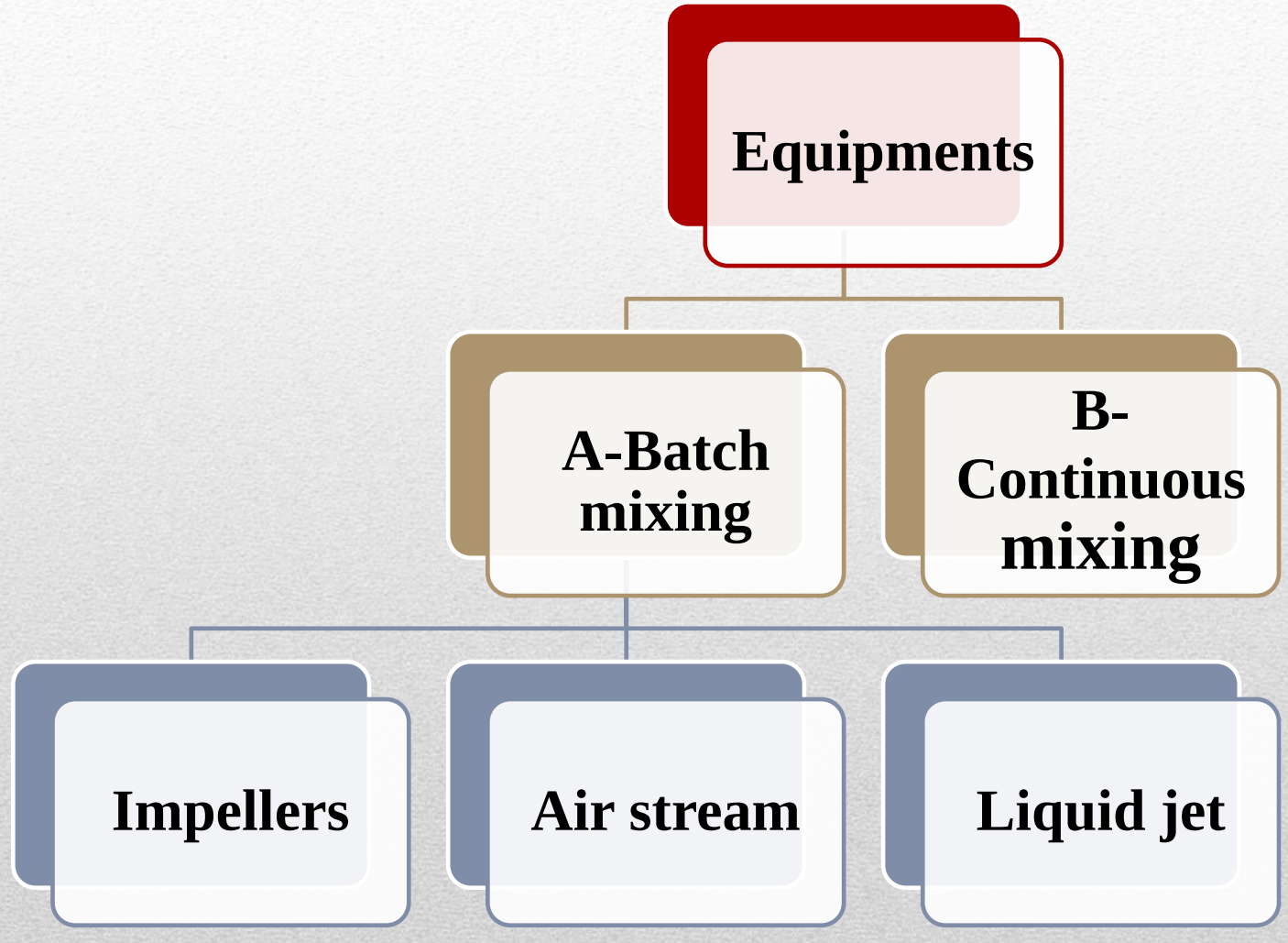
Mixing at the molecular level by diffusion resulting from thermal motion of molecules.

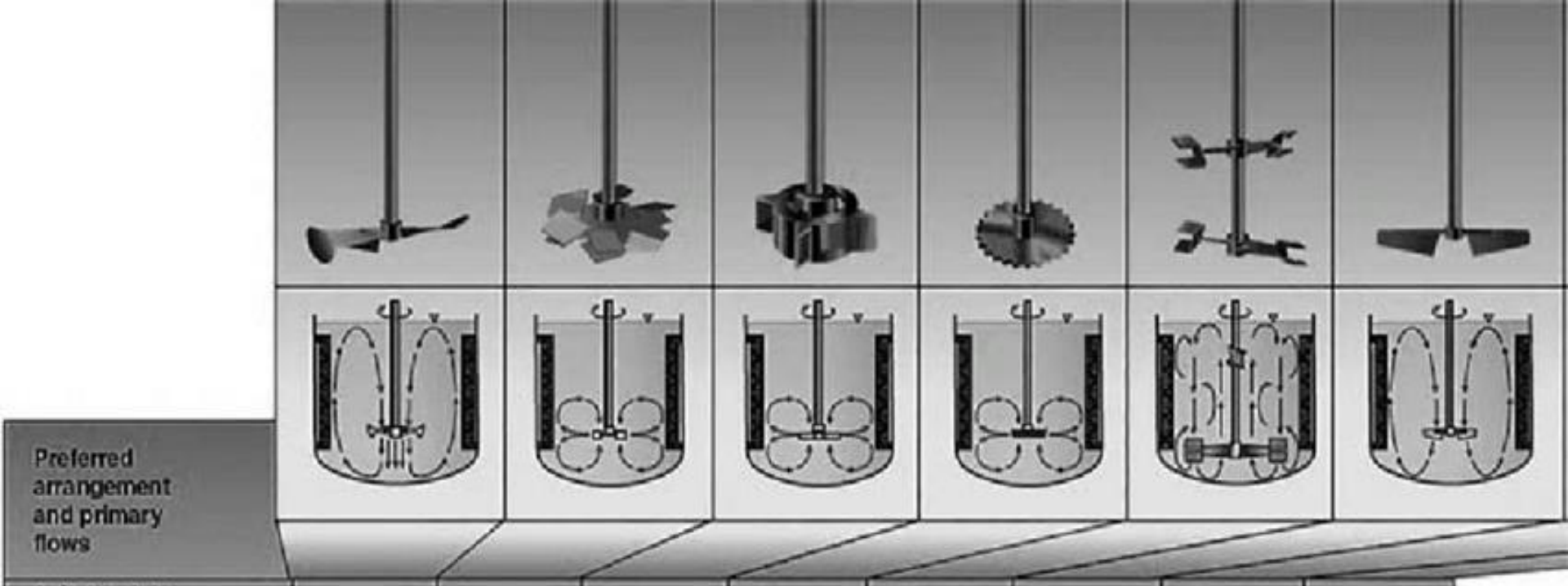
Occurs in conjugation with laminar flow that tends to reduce sharp discontinuities at the interface between the fluid layers which leads to complete mixing after sufficient time.

https://www.youtube.com/watch?v=EDehKF5sH9Y

https://www.youtube.com/watch?v=tgODpDhrE6k

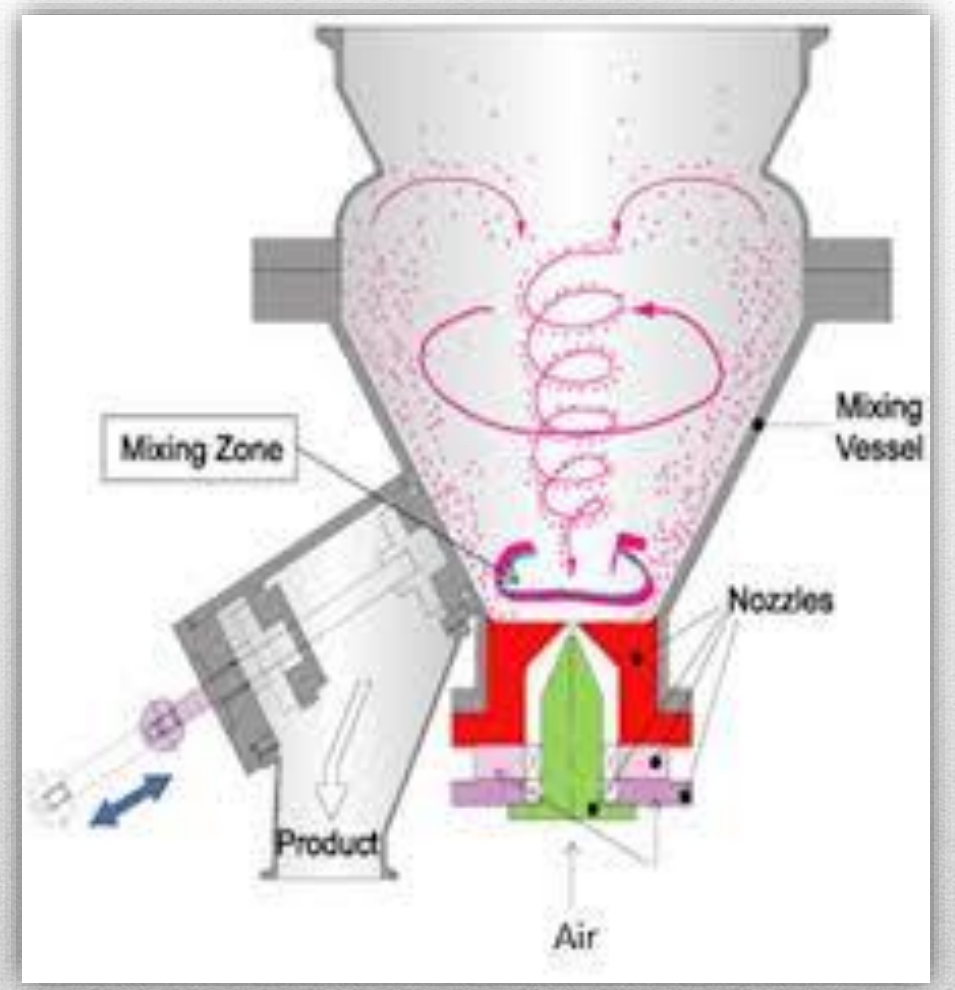
Equipments

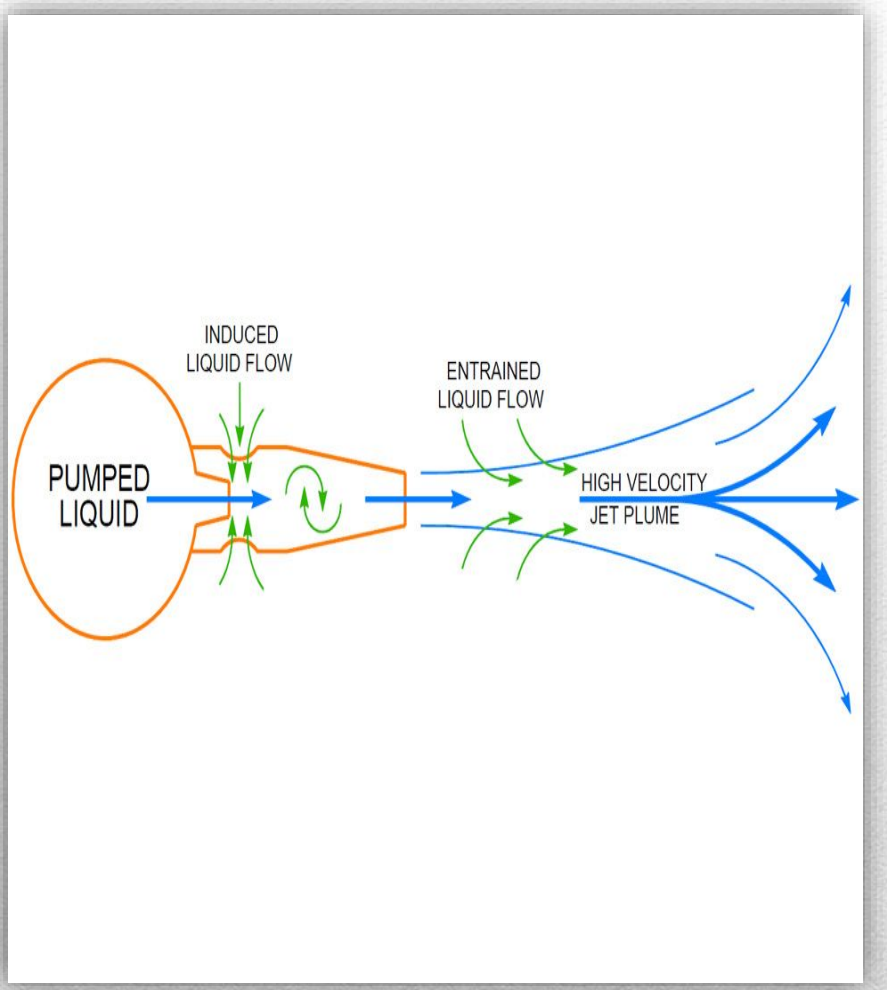

Equipments
A-Batch mixing
B- Continuous mixing
Impellers
Air stream
Liquid jet



Preferred arrangement and primary flows								
Agitator duty:								
Blending	T				Tr	NN Tr T	L NN Tr T	L NN Tr T
Suspension	T				Tr	T		NN Tr T
Dispersion gas/liquid		T	T					
Dispersion liquid/liquid				Tr T		Tr		L NN Tr T
Dispersion solids/liquid				Tr T		Tr		L NN Tr T
Heat transfer	T	T	T		Tr	NN Tr T	Tr L NN	L NN Tr T
Flow regime/ viscosity	T = Turbulent, low viscosity				L = Laminar, high vicosity			
	Tr = Transition region, medium viscosity				NN = Non-Newtonian flow properties			

Modern impellers for mixing



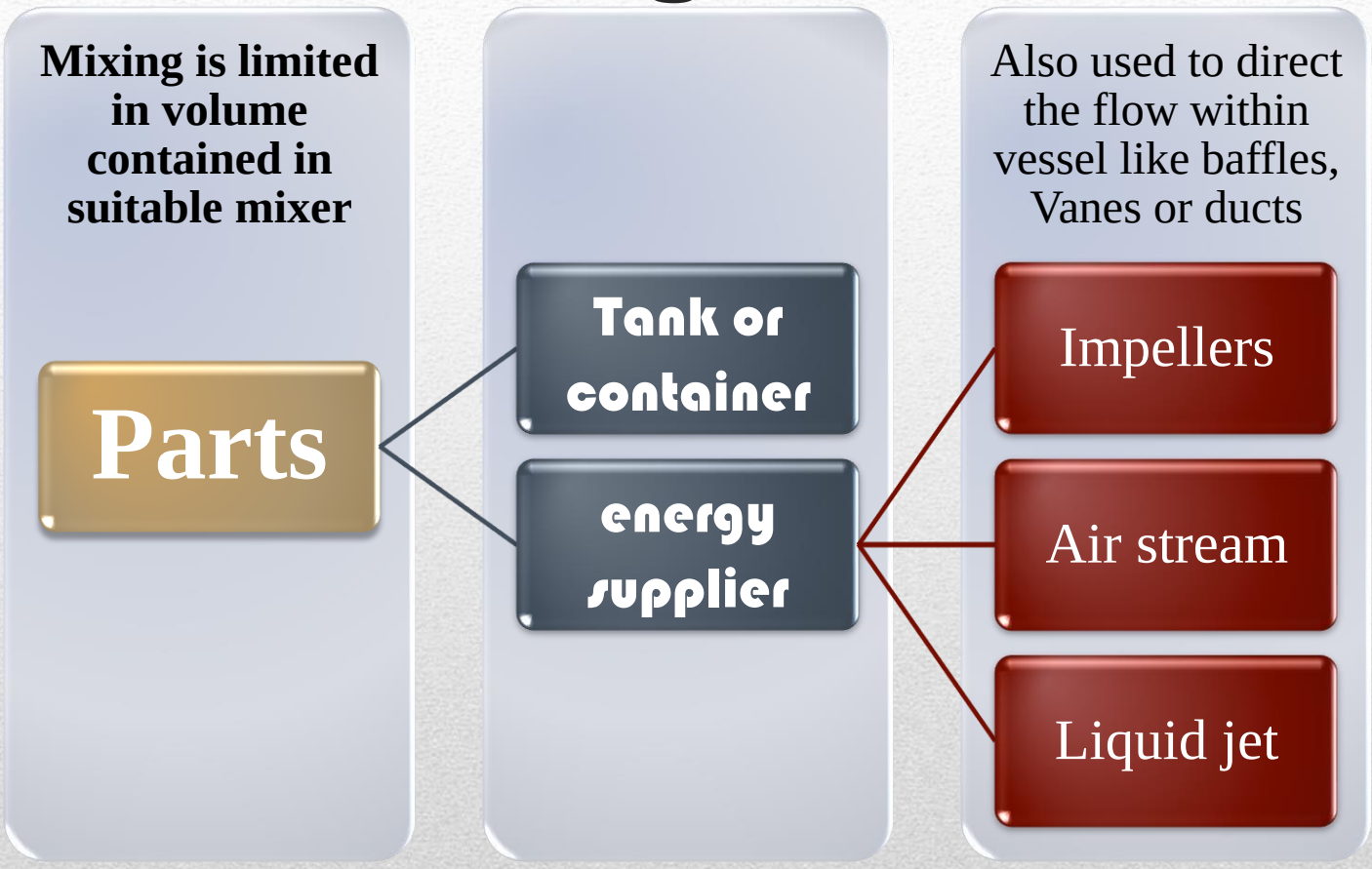


Air stream mixer

Fluid jet mixer

https://www.youtube.com/watch?v=EF00LgoDmD4

A. Batch Mixing



https://www.youtube.com/watch?v=J96TEOjgscE

https://www.youtube.com/watch?v=I6hpt0baGt4

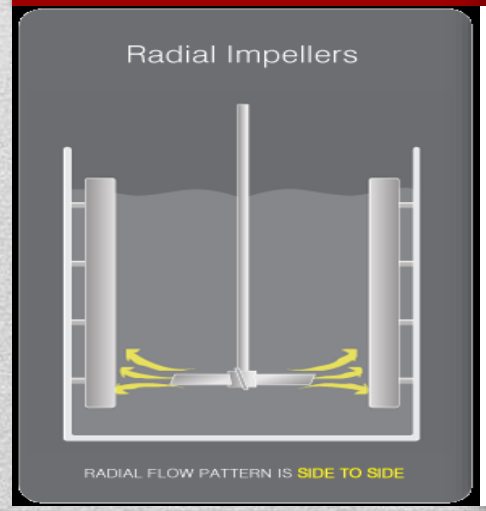
https://www.youtube.com/watch?v=AaYFIudwiyE

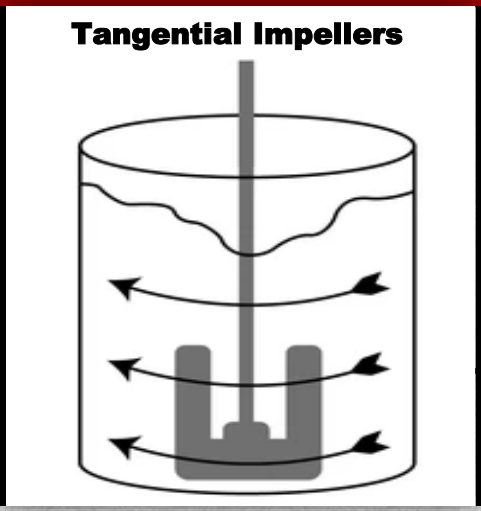
Impeller types

Types of impeller depend on

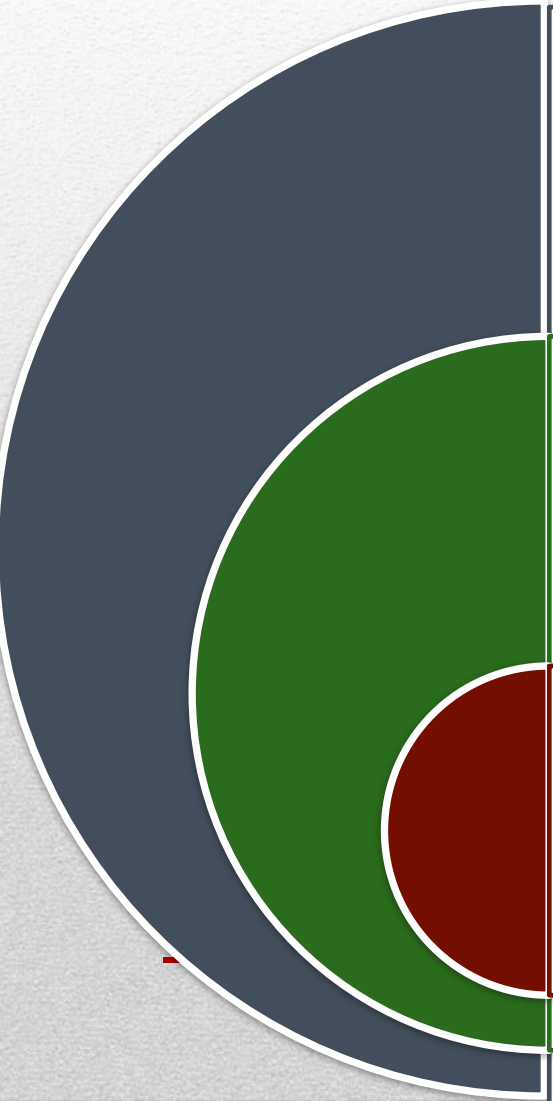
1- Type of flow (radial, axial, tangential)

2- Shape and pitch of blades





Impeller types



Propellers

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

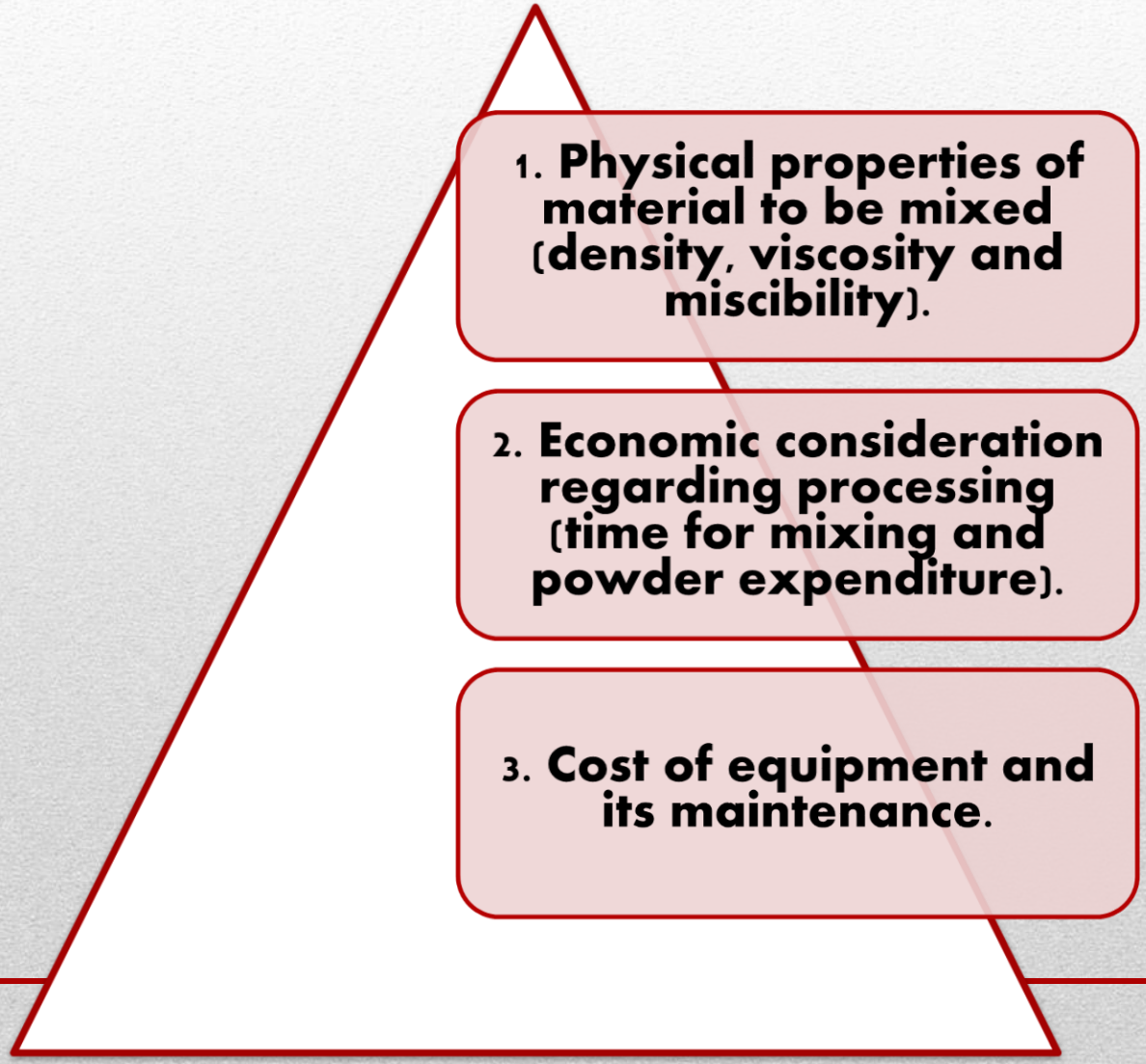
Turbine

- 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.

Factors affecting mixer selection



Mixers in polyphase systems

Liquid –liquid mixing

- **Mixing of two immiscible liquids requires subdivision of one of the phases into globules which then distributed throughout bulk of 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.**

Experiment 1: Liquid-Liquid mixing:

O/W emulsion

Castor oil 35%

Tween 80 8.75%

D.W. up to 100 ml

Note: ingredients mix in a ratio of 4:2:1 (oil:water:E.A.)

Procedure:

1. Mix castor oil (35 ml) with Tween (8.75 ml) in a mixer for 1 min.
2. Add D.W. (17.5 ml) and mix in a mixer for 2 min.
3. Transfer to a graduated cylinder and wash mixer with D.W. then complete to 100 ml in a graduated cylinder.

Experiment 2: Solid-Liquid mixing:

Suspension

Mg oxide 200 mg / 5 ml

Glycerin 10%

D.W. up to 100 ml

Procedure:

1. Add Mg oxide 4 gm (4000 mg) to 10 ml glycerin with little amount of water and mix in a mixer for 1 min .
2. Move the mixture to a graduated cylinder and wash mixer with D.W. then complete to 100 ml in a graduated cylinder.


Thank You