Pharmaceutical Unit Operations

MIXING

10th week

MIXING

Mixing is defined as a process that tends to result in a randomization of dissimilar particles within a system.

The term MIXING means to put together in one mass.

The term BLENDING means to mix smoothly and inseparably together during which a minimum energy is imparted to the bed.

MIXING and BLENDING are commonly used interchangeable in the pharmaceutical industry.

- Mixing may be defined as an operation in which two or more components, in a separate or roughly mixed condition, are treated so that each particle lies as nearly as possible in contact with a particle of each of the other ingredients.

- This process may involve the mixing of gases, liquids or solids in any possible combination and in any possible ratio of two or more components.

Examples of large scale mixing practiced in pharmacy are:

- Mixing of powders in varying proportions prior to granulation or tabletting
- Dry mixing of the materials for direct compression in tablets
- Dry blending of powders in capsules and compound powders
- Blending of powders in cosmetics in the preparation of face powders, tooth powders
- Dissolution of soluble solids in viscous liquids for dispensing in soft capsules and in the preparation of syrups
- Mixing of two immiscible liquids for preparation of emulsions

Depending on the flow properties of materials, solids are divided into two types:

1. Cohesive materials - These are characterized by their resistance to flow through openings for e.g. wet clay.

2. Noncohesive materials - These materials flow readily such as grain, dry sand, plastic chips etc.

Mixing of cohesive materials is more difficult due to formation of aggregates and lumps.

Wet mixing is encountered in pharmacy as an individual operation or as a subsequent step after dry blending.

In pharmaceutical practice, solid-solid, solid-liquid and liquid-liquid mixing are generally batch operations where the batch may be as large as one ton.

Objectives of mixing

Mixing can be done for the following reasons

- To ensure that there is uniformity of composition between the mixed ingredients which may be determined by taking samples from the bulk material and analyzing them, which should represent overall composition of the mixture.

- To initiate or to enhance the physical or chemical reactions e.g. diffusion, dissolution etc.

Mixing is performed to obtain following type of products;

- When two or more than two miscible liquids are mixed together, this results into a solution known as *true solution.*
- When two immiscible liquids are mixed in the presence of an emulsifying agent, an *emulsion* is produced.
- When a solid is dissolved in a vehicle, a *solution* is obtained
- When an insoluble solid is mixed with a vehicle, a *suspension* is obtained.
- When a solid or liquid is mixed with a semisolid base, an *ointment or a suppository* is produced.
- When two or more than two solid substances are mixed together, a powder is obtained which when filled into *capsule* shell is known as capsules and when compressed under heavy pressure is called *tablet.*

Types of Mixtures

1. Positive mixtures
2. Negative mixtures
3. Neutral mixtures

Types of Mixtures

Positive Mixtures

These types of mixtures are formed when two or more gases or miscible liquids are mixed together by means of diffusion process.

There is no input of energy required with positive mixtures if the time available for mixing is unlimited, although input of energy will shorten the time required to obtain the desired degree of mixing.

These types of materials do not create any problem in mixing.

Types of Mixtures

Negative Mixtures

These types of mixtures are formed when insoluble solids are mixed with a vehicle to form a suspension or when two immiscible liquids are mixed to form an emulsion.

These mixtures are more difficult to prepare and require a higher degree of mixing with external force as there is tendency of the components of these mixtures separate out unless they are continuously stirred.

Types of Mixtures

Neutral Mixtures

Many pharmaceutical products such as pastes, ointments and mixed powders are the examples of neutral mixtures. They are static in their behavior.

The components of such products do not have any tendency to mix spontaneously but once mixed, they do not separate out easily.

I- Powder Mixing

- Powder mixing is a process in which two or more solid substances are intermingled in a mixer by continuous movement of the particles.

- Mainly, the object of mixing operation is to produce a bulk mixture which when divided into different doses, every unit of dose must contain the correct proportion of each ingredient. The degree of mixing will increase with the length of time for which mixing is done.

- Powder mixing is a neutral type of mixing. It is one of the most common operations employed in pharmaceutical industries for the preparation of different types of formulations, e.g. **powders, capsules and tablets**.

I- Powder Mixing

- To obtain good results of powder mixing, the following factors and physical properties of drugs must be taken into consideration before undertaking any kind of powder mixing.
- It is easier to mix equal weights of two powders of similar fineness and density than to incorporate a small proportion of a fine powder in a large mass of a coarse denser material.
- Apart from density and particle size, the stickiness of the components to be mixed is also important. Prolonged mixing becomes necessary to effectively distribute materials like lubricants and wetting agents into tablet granules.

I- Powder Mixing

- Also wide differences among properties such as particle size distribution, shape and surface characteristics such as surface area and electrostatic charges may take blending very difficult. Flow characteristics such as angle of repose and ability to flow, abrasiveness of one ingredient upon the other, state of agglomeration of the ingredients, moisture or liquid content of the solids, density, viscosity and surface tension at operating temperature of any liquid added, are some other significant considerations in mixing and selection of mixing equipments.

Mixing Mechanisms for Powders

There are three main mechanisms by which powder mixing occurs namely;

- Convective mixing
- Shear mixing
- Diffusive mixing

Convective mixing

During convective mixing transfer of groups of particles in bulk take place from one part of powder bed to another.

Transfer of groups of particles takes place from one location to another by means of blades or paddles of the machine.

Convective mixing is referred to as macromixing.

Shear mixing

Shear mixing occurs when a "layer" of material moves over another "layer".

During shear mixing, shear forces are created within the mass of the material by using agitator arm or a blast of air.

Diffusive mixing

In order to achieve a true random mix, movement of individual particles is required. This occurs with diffusive mixing.

During this mechanism, mixing occurs by diffusion process by random movement of particles within a powder bed and cause them to change their relative positions.

During this mixing, the materials are tilted so that the gravitational forces cause the upper layers to slip and diffusion of individual particles take place over newly developed surfaces.

Diffusion is also referred to as micromixing.

* All three mixing mechanisms are likely to occur in a mixing operation.

* Which mechanism predominates and the extent to which each occurs will depend on the mixer type, mixing process conditions (mixer load, mixing speed etc) and the flowability of the components of the powder.

Powder segregation (Demixing)

Segregation is the opposite effect to mixing, i.e. components tend to separate out.

This is very important in the preparation of pharmaceutical products because if it occurs, an already formed random mix may change to a non-random mix or a random mix may never be achieved.

Care must be taken to avoid segregation occuring during handling after powders have been satisfactorily mixed, e.g. during transfer to filling machines or in the hopper of a tablet / capsule filling machine.

Segregation will cause an increase in content variation in samples taken from the mix and may cause a batch to fail a uniformity of content test.

If segregation of granules occurs in a hopper of a filling machine, an unacceptable variation in weight may result.

Smaller particles tend to fall through the voids between larger particles and thus move to the bottom of the mass. This is known as ***percolation segregation***.

It may occur in static powder beds if the percolating particles are so small that they can fall into the void spaces between larger particles, but occurs to a greater extent as the bed "dilates" on being disturbed.

Domestically, percolation segregation is often observed in cereal packets or coffee jars where the smaller particles congregate towards the bottom of the container.

Percolation can occur whenever a powder bed containing particles of different size is disturbed in such a way that particle rearrangement occurs, e.g. during vibration, stirring or pouring.

During mixing, larger particles will tend to have greater kinetic energy imparted to them (owing to their larger mass) and therefore move greater distances than smaller particles before they come to rest.

This may result in separation of particles of different size; an effect referred to as ***trajectory segregation*.**

This effect, along with percolation segregation, accounts for the occurence of the larger particles at the edge of a powder heap when it is poured from a container.

During mixing or when a material is discahrged from a container, very small particles (dusts) in a mix may tend to be "blown" upwards by turbulent air currents as the mass tumbles and remain suspended in the air during mixing.

When the mixer is stopped or material discharge is complete, these particles will sediment and subsequently form a layer on top of the coarser particles.

This is called ***elutriation segregation*** and is also referred to as ***dusting out*** or ***fluidization segregation***.

Physical properties affecting mixing

Material density:

*If the components are of different density, the denser material will sink through the lighter one, the effect of which will depend on the relative positions of the material in the mixer.

*If the denser particles form the lower layer in a mixture at the start of a mixing operation, the degree of mixing will increase gradually until equilibrium is attained, not necessarily complete mixing.

*If the denser component is above, the degree of mixing increases to a maximum, then dropping to equilibrium as the denser component falls through the lighter one, so that segregation has started.

*This factor is of practical significance in charging and operating a mixer.

Physical properties affecting mixing

***Particle size*:**

A difference in particle sizes of components is the main cause of segregation in powder mixes in practice.

Smaller particles tend to fall through the voids between the larger particles and thus move to the bottom of the mass.

Physical properties affecting mixing

***Particle shape*:**

The ideal particle is spherical in shape and further the particles depart from this theoretical form, the greater the difficulty of mixing.

Spherical particles exhibit the greatest flowability and therefore are more easily mixed but they also segregate more easily than non-spherical particles.

If the particles are of irregular shapes, then they can become interlocked leading to a decrease in the risk of segregation once mixing has been achieved.

Physical properties affecting mixing

Particle attraction:

Some particles exert attractive forces; this may be due to adsorbed liquid films or electrostatic charges, such particles tending to aggregate.

Since these are surface properties, the effect increases as particle size decreases.

Ordered Mixing

It would be expected that a mix composed of very small and much larger particles would segregate because of the size differences.

Sometimes, if one powder is sufficiently small (micronized) it may become adsorbed onto active sites on the surface of a larger carrier particle.

Here it will exhibit a greater resistance to being dislodged. This has the effect of minimizing segregation while maintaining good flow properties.

The phenomenon is referred to as **ordered mixing**.

If a carrier particle is removed then some of the adsorbed smaller particles will automatically be removed with it.

Ordered mixing has been shown to be important in direct-compression tablet formulations in preventing segregation of drug from direct compression bases.

POWDER MIXING EQUIPMENT

Tumbling mixers / blenders

High speed mixer – granulator

Fluidized bed mixers

Agitator mixers

Tumbling mixers / blenders

They are commonly used for mixing of granules or free-flowing powders.

There are many different designs of tumbling mixer;

- Double cone
- Twin Shell (V)
- Cube
- Y-cone
- Intermediate bulk containers (IBCs)
- Turbula shaker mixer

Mixing containers are generally mounted so that they can be rotated about an axis.

Shear mixing will occur as a velocity gradient is produced, the top layer moving with the greatest velocity and the velocity decreasing as the distance from the surface increases.

When the bed tumbles it dilates, allowing particles to move downwards under gravitational force, and so diffusive mixing occurs.

Too high a rotation speed will cause the material to be held on the mixer walls by centrifugal force and too low a speed will generate insufficient bed expansion and little shear mixing.

Addition of prongs, baffles or rotating bars will also cause convective mixing.

Tumbling mixers are available to mix from approximately 50 g to over 100 kg.

The material typically occupies about a half to two-thirds of the mixer volume.

The rate at which the product is mixed will depend on the mixer design and rotation speed since they influence the movement of the material in the mixer.

It is now common to use the *intermediate bulk containers* as both the mixer bowl and to feed the hopper of a tablet or as the capsule machine or as the hopper itself.

Turbula shaker mixer is a more sophisticated form of tumbling mixer which utilizes inversional motion in addition to the rotational and translational motion of traditional tumbling mixers.

This leads to more efficient mixing and makes it less likely that material of different size and density will segregate.

High speed mixer – granulators

It can both mix and granulate a product thus removing the need to transfer the product between pieces of equipment and thereby reducing the opportunity for segregation to occur.

The centrally mounted impeller blade at the bottom of mixer rotates at high speed, throwing the material towards the mixer bowl wall by centrifugal force.

The material is then forced upwards before dropping back down towards the centre of the mixer.

The particulate movement within the bowl tends to mix the components quickly owing to high shear forces and the expansion in bed volume which allows diffusive mixing.

Once mixed, granulating agent can be added and granules formed in situ using a slower impeller speed and the action of the side-mounted chopper blade.

Fluidized –bed mixers

The main use of this equipment is in the drying of granules or the coating of multiparticulates.

Fluidized bed can also be used to mix powders prior to granulation in the same bowl.

Agitator mixers

This type of mixer depends on the motion of a blade or paddle through the product and hence the main mixing mechanism is convection.

Ribbon mixer

Planetary mixer

Nautamixer

Ribbon mixer

Mixing is achieved by the rotation of helical blades in a hemispherical trough.

Dead spots are difficult to eliminate in this type of mixer and the shearing action caused by the movement of the blades may be insufficient to break up drug aggregates.

However, it mixes poorly flowing material and is less likely to cause segregation than a tumbling mixer.

Planetary mixer

The mixing bowl is shown in the lowered position for filling and emptying.

The bowl is raised up to the mixing blade for the mixing process.

The mixing blade is set off centre and is carried on a rotating arm. It therefore travels round the circumference of the mixing bowl while simultaneously rotating around its own axis.

Nautamixer

It consists of a conical vessel fitted at the base with a rotating screw which is fastened to the end of a rotating arm at the upper end.

The screw conveys the material to near the top where it cascades back into the mass.

The mixer thus combines convective mixing (as the material is raised by the helical conveyor) and shear and diffusive mixing (as the material cascades downwards).

II. Liquid Mixing

Liquid mixing may be divided into following two subgroups:

1. Mixing of liquids and liquids

a) Mixing of two miscible liquids

b) Mixing of two immiscible liquids

2. Mixing of liquids and solids

a) Mixing of liquids and soluble solids

b) Mixing of liquids and insoluble solids

II. Liquid Mixing

1. (a) Mixing of two miscible liquids (homogeneous mixtures e.g. solutions)

Mixing of two miscible liquids is quite easy and occur by diffusion. Such type of mixing does not create any problem.

Simple shaking or stirring is enough but if the liquids are not readily miscible or if they have very different viscosities then electric stirrer may be used.

II. Liquid Mixing

1. (b) Mixing of two immiscible liquids (heterogenous mixtures e.g. emulsions)

- Two immiscible liquids are mixed to effect transfer of a dissolved substance from one liquid to another. When two immiscible liquids are mixed together in the presence of an emulsifying agent **an emulsion** is produced.

- For the production of a stable emulsion, the mixing must be very efficient i.e. continuous without ceasing because the components tend to separate out if continuous work is not applied on them.

II. Liquid Mixing

2. (a) Mixing of liquids and soluble solids (homogeneous mixtures e.g. solutions)

- In this case soluble solids are dissolved in a suitable liquid by means of stirring.

- It is a physical change i.e. a soluble solid is converted to a solution.

II. Liquid Mixing

2. (b) Mixing of liquids and insoluble solids (heterogeneous mixtures e.g. suspensions)

When insoluble solids are mixed with a liquid, **a suspension** is produced which is an unstable system.

The ingredients of a suspension separate out when allowed to stand for sometime. Thus a suspending agent is required to produce a stable suspension.

On small scale, suspensions may be prepared in a pestle and mortar.

Mixing mechanisms for fluids

Mixing mechanisms for fluids fall essentially into four categories:

Bulk transport

Turbulent flow

Laminar flow

Molecular diffusion

Usually more than one of these processes is operative in practical mixing situations.

1.Bulk transport

The movement of a relatively large amount of the material being mixed from one location in the system to another constitutes bulk transport.

2.Turbulent Mixing

The phenomenon of turbulent mixing is a direct result of turbulent fluid flow, which is characterized by a random fluctuation of the fluid velocity at any given point with in the system.

The velocity of the liquid is varied in different regions of the liquid. Therefore, turbulence occurs in the system as a result of temporary and variable speed difference and ensures that the mixing process is random.

This mechanism is very effective in mixing.

The density of the liquid is also important in turbulence flow in terms of mixing speed.

3.Laminar mixing

Streamline or laminar flow is frequently encountered when highly viscous liquids are being processed. This mixing mechanism occurs in highly viscous liquids.

It can also occur if stirring is relatively gentle and may exist adjacent to stationary surfaces in vessels in which the flow is predominantly turbulent.

It is formed by sliding two dissimilar layers of liquid over each other. These layers may also be more than one.

4.Molecular diffusion

The primary mechanism responsible for mixing at the molecular level is diffusion resulting from the thermal motion of the molecules.

Mixing occurs when the liquid molecules to be mixed move randomly within each other.

The process is described quantitatively in terms of Fick’s law of diffusion.

LIQUID MIXING EQUIPMENT

Propeller mixers

Paddle mixers

Turbine mixers

In-line mixers

Propeller mixers

Propellers are commonly used for mixing miscible and immiscible liquids of low viscosity.

A propeller has angled blades which cause the circulation of the fluid in both an axial and radial direction.

High speed rotation (400 – 1500 rpm) of the relatively small element provides high shear rates in the vicinity of the impeller and a flow pattern with mainly axial and tangential components.

The marine propeller is typical of the group.

An off-centre mounting discourages the formation of a vortex, which may form when the stirrer is mounted centrally.

A vortex forms when the centrifugal force imparted to the liquid by the propeller blades causes it to back up round the sides of the vessel and form a depression around the shaft.

As the speed of rotation is increased, air may be sucked into the fluid due to the formation of a vortex; this can cause frothing and possible oxidation.

Another method of supressing a vortex is to fit vertical baffles into the vessel. These baffles divert the rotating fluid from its circular path into the centre of the vessel where the vortex would otherwise form.

The ratio of the diameter of a propeller strirrer to the diameter of the vessel is commonly 1:10 to 1:20.

Paddle mixers

The mixing element is large in relation to the vessel and rotates at low speeds (10-100 rpm).

A simple paddle, with upper and lower blades, suitable for mixing miscible liquids of low viscosity.

The gate paddle is suitable for mixing liquids of higher viscosity.

Anchor paddle with low clearance between pan and blade is useful for working across a heat transfer surface.

Turbine mixers

Turbine designs are intermediate between paddles and propellers.

Turbines are effective mixers over a wide viscosity range and provide a very versatile mixing tool.

The impeller has four flat blades surrounded by perforated inner and outer diffuser rings.

The rotating impeller draws the liquid into the mixer head and forces the liquid through the perforations with considerable radial velocity sufficient to overcome the viscous drag of the bulk of the fluid.

One drawback is the absence of an axial component but a different head with the perforations pointing upwards can be fitted if this is desired.

As the liquid is forced through the small orifices of the diffuser rings at high velocity large shear forces are produced.

When mixing immiscible liquids, if the orifices are sufficiently small and velocity sufficiently high, the shear forces produced enable the generation of droplets of the dispersed phase which are small enough to produce stable dispersions (w/o or o/w).

Turbine mixers of this type are therefore often fitted to vessels used for the large scale production of emulsions and creams.

Turbine type mixers will not cope with very high viscous liquids since the material will not be drawn into the mixer head.

In – line mixers

As an alternative to mixing fluids in batches in vessels, mobile miscible components may be fed through an in-line mixer designed to create turbulence in a flowing fluid stream.

In this case, a continous mixing process is possible.

III. Semi-Solid Mixing

The problems that arise during the mixing of semi-solids (ointments and pastes) stem from the fact that, unlike liquids, semi-solids will nor flow easily. Material that finds its way to a dead spot will remain there.

For this reason, suitable mixers must have rotating elements with narrow clearances between themselves and the mixing vessel wall and they must produce a high degree of shear mixing since diffusion and convective mixing cannot occur.

SEMI-SOLID MIXING EQUIPMENT

Planetary mixers

Sigma blade mixers

Planetary mixers

This type of mixer is commonly found in the domestic kitchen and larger machines which operate on the same principle are used in the pharmaceutical industry.

When used for the mixing of semi-solids, they are designed so that there is only a small clearance between the vessel and the paddle in order to ensure sufficient shear.

Sigma blade mixers

This robust mixer will deal with stiff pastes and ointments and depends for its action on the close intermeshing of the two blades which resemble the Greek letter (Σ) in shape – hence the name.

It is very difficult, using primary mixers, to completely disperse powder particles in a semi-solid base so that they are invisible to the eye.

The mix is usually subjected to the further action of a **roller mill** or **colloid mill** so as to rub out these particles by the intense shear generated by rollers or cones set with a very small clearance between them.

TRANSMISSION OF LIQUIDS

Transmission of liquids:

- Transmission by gravity

- Transmission by pumps

Transmission of liquids by gravity:

-It is a method used for the liquids which are non-resistant to flow

-The tank in which the solution is prepared is at a high level and the vessel to be drained is at a lower level.

* With this method the transmission is either between different levels on the same floor or between two layers / floors.

* It is cheaper in terms of not using more tools but it is a time consuming method in terms of slow processing.

Transmission of liquids by pumping:

-The solutions are transmitted from one place to another by means of machines which give energy, ie, pressurize the liquid.

-Generally, the machines that transfer the energy from outside to the passing liquid are called pumps.

The energy that a pump will transfer to the liquid is provided by the connection of an electric / petrol engine to the shaft of the pump.

Bernoulli Theorem:

In systems where a liquid is passing through, the total mechanical energy at any point is equal to the sum of the potential, kinetic, and pressure energies of the liquid at that point.

It is also called 'energy equation for constant flow'

In this theory……

Conservation of the matter

Conservation of the energy

Friction resistance

are the three factors.

Conservation of matter:

When the flow is constant, the amount of liquid passing through any point of the system is constant.

Conservation of energy:

The energy that the liquid has at the pump inlet must be equal to the energy it has at the pump outlet.

The liquid has four types of energy at the time flow:

1- Potential energy

2- Kinetic energy

3- Internal energy

4- Pressure energy

Potential energy: It is the energy that the liquid has because it is raised above the initial level.

Kinetic energy: Liquid, as a material moving with a velocity, V, in the pipe, has a kinetic energy.

Internal energy: It is the energy that the liquid has due to the molecular motion.

Pressure energy: It is the energy that the liquid has due to its presence in the system.

Friction resistance:

It is a condition that occurs between the liquid and the wall of the system in which the liquid flows and that causes energy loss.

PUMPS:

They provide the flow of liquids by converting the potential, kinetic and pressure energy that the liquids possess into mechanical energy.

Pumps are used in the delivery of fluids for three purposes:

- **Raising the liquid level:** both the suction and the pressurizing force take the liquid from the lower level to the pump outlet

- **Reduction of friction resistances:** energy loss caused by the friction while the passing of the liquid through the pipe is compensated by the pump

- It gives kinetic energy for defeating the stability of the liquids and moving it in linear velocity in the pipe

Classification of Pumps

Volumetric Pumps

Piston pump

Diaphragm pump

Wing pump

Gear pump

Lobe pump

Peristaltic pump

Screw pump (monopomp)

Centrifugal Pumps

Volumetric Pumps

- They deliver a constant volume of liquid at each cycle of the pump.
- Piston, diaphragm, wing pumps deliver the liquid by the forward and backward movement of the piston.
- The other pumps are operated via a rotating shaft. They provide motion by compressing the liquid with the rotation of the gear, lobe or screw.
- They provide a high pump head to the liquid.
- Energy transmission is intermittent / non-continuous.

Piston Pumps

- They operate on the basis of the pressure that a piston moving forward and backward inside a cylinder makes on the liquid.
- The cylinder has inlet and outlet valves.
- When the piston comes back, the vacuum formed in the cylinder opens the inlet valve and the cylinder is filled with a certain amount of liquid.
- When the piston moves forward, the inlet valve is closed by the pressure, the outlet valve is opened and the liquid is pushed out. They are used for the transmission of very small amounts of liquid and for a high pump head.

- They are not used in the transmission of abrasive and viscous liquids as they may leak from the edges of the piston and the segments.
- By adjusting the space created by the movement of the piston in the cylinder, they pump a measured amount of liquid and they are used to fill the drug containers directly with a certain amount of solution.

Diaphragm Pumps

- They are like piston pumps. In these systems, the piston is not in contact with the liquid to be transmitted.
- There is a flexible, steel or plastic diaphragm, a curtain, between the piston and the liquid.
- Since the diaphragm is adherent to the cylinder, there is no leakage. As the piston moves forward and backward, the diaphragm buckles forth and back to draw and push the liquid in front, since it is flexible.
- They are used for abrasive liquids such as gasoline, acid and alkali.
- These pumps are also used for the transmission of certain amount of liquids.

Gear Pumps

- In such machines, the energy transmission / movement occurs with the help of two gears rotating in a body.
- One of these gears is rotated externally by the engine. The other gear is engaged in this action due to the intermeshing of the gears. In this way, the two gears rotate in the opposite direction.
- They are suitable for viscous liquids.
- They are not suitable for abrasive liquids.

Lobe Pumps

- These are the machines that transmit energy by the use of lobes that have a more flat surface and allow operation without noise, instead of gears.
- They are widely used for low density liquids and gases.

Wing Pumps

- They consist of an eccentric rotor rotating in the cylinder and pallets (paddles) moving in and out of the rotor through springs.
- The pallets (paddles) extend and shorten with the aid of the spring, allowing the rotor to contact the outer cylinder. This movement of the rotor in the cylinder provides the flow of liquid.
- It provides liquid transmission in a measurable amount.

Peristaltic Pumps

- They are used in situations where it is necessary to avoid metal contact and where sterilization is the first requirement.
- The liquid is transmitted by a peristaltic effect from a plastic pipe. The pipe is secured between the semicircular stationary block and the rotating ball plate to provide the flow of liquid.
- It is used to transmit parenteral solutions to filtration devices.

Screw Pumps

- They consist of a rubber stator and a screw / helix rotor rotating inside the stator.
- They provide high pressure.

They are used;

-for the transmission of semi-solid preparations

-for the liquids to be transferred to filtration devices

-when the transmission line is long

Centrifugal Pumps

* They have a high rotation speed.

* The volume of the liquid transmitted is not constant.

* Energy transmission is continuous.

* They provide a continuous flow and speed.

Centrifugal Pumps

- They are the pumps that give energy, especially kinetic energy, to the liquid basically by centrifugal force.

- They consist of a propeller rotating in a snail-shaped housing.

- The liquid enters between the vanes rotating from the center. The liquid is sucked up by the centrifugal force which is provided by the rotation of the propeller, and is rapidly discharged to the outside.

- They are preferred for draining high amounts of liquids, dirty and dishwashing water. They are used to transmit liquids and suspensions containing fibrous and soft solids.

- They are also used for transporting abrasive fluids.

Terms Used in the Evaluation of Pumps

Flow Rate: The amount (volume or weight) of liquid passing through a pump in a unit of time (m3/sec, L/h)

Pump Head (Hm): The difference in the energy of liquid between the discharge side and the suction side of the pump (Kg.m)

Also called as manometric discharge head (m)

Cycle Number: The cycle of the pump in a minute (cycle/min)

Yield: The ratio of “the energy that the pump transfers to the liquid passing through it” to “the energy delivered from outside to the pump shaft”.

Yield = Power transferred to liquid / Power transferred to pump shaft

Power: The amount of work in a unit of time, required for the pump to be driven

Work / time= joule / sn = Watt

1 horse power = 746 Watt

Selection of Pumps

- Power to be applied to the pump and the yield of the pump
- Desired pumping speed
- Pumping pressure
- The compatibility of the product with pump surfaces
- Whether or not a measured amount of transmission is necessary
- Properties of the material to be transmitted; abrasive, viscous or semi-solid

Selection of Pumps

- When a measured amount of transmission is required: piston, diaphragm or wing pumps
- For liquids to be transmitted to filtration devices: screw (monopomp) or peristaltic pumps
- For the transmission of liquids in large quantities: centrifugal pumps

References

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