Hello students,

welcome to today's e-learning session.

Today's topic will be centrifugation.

This is part of Unit 4 of

industrial microbiology.

The outline of this session is as follows.

We will look at introduction and

definition of centrifugation,

the principle of centrifugation.

We look at the relationship between

RPM and we will look at the choice

between filtration or centrifugation

and then we will look at how batch

centrifuges and continuous

centrifuges in industry work.

At the end of this session,

a student should be able to understand

the concept of centrifugation.

Here it should be able to differentiate

between the need for filtration or

centrifugation during downstream processing,

and we should be able to describe batch

and continuous processes of centrifugation.

When we talk about downstream processing,

there are different stages

in downstream processing.

The very first stage involves

cell disruption,

where the contents of this

cell are opened or removed,

and then the insoluble products

have to be separated out.

Now,

this removal of insoluble products

is done by different methods out of

which we will look at centrifugation

in this particular module.

Downstream processing also involves

the purification of the product

and finally the product polishing.

When we have particles in a suspension,

normally they will sediment to the

bottom of the vessel over a period

of time and this is because of the

effect of the Earth's gravitational

field or what we express as G.

But sometimes this will take a very

very long period of time and in

industry we do not have that kind of

time to wait for this sedimentation

due to gravitational force.

In such situations we use centrifugation

where we can increase the rate of

sedimentation by spinning the samples

and creating a centrifugal force,

and this centrifugal force will

act on the particles and will

cause them to sediment out.

So centrifugation can be defined

as a technique of separating

components where centrifugal force

will cause the denser molecules

to move towards the periphery or

to move towards the outer surface,

and the less dense particles will still

remain in the center of that centrifuge.

The process of centrifugation will

rely on the perpendicular force

which is created when a sample

is rotated about a fixed point.

And there are several factors

which centrifugation depends on and

one of the important factor is it

depends on the size of the particle

on the density of the particles

which are present in the solution.

So the principle of

centrifugation is as such.

When a particle is subjected

to a centrifugal force when

it is rotated at high speed,

then the centrifugal force given as

F is directly proportional to the

mass of the sedimenting particles.

That means how much of mass

that particular particle has?

It depends on the angular

velocity of rotation.

That means the angle of that rotor.

And it depends on

what is the distance of the

migrating particle from this

central axis of rotation.

Now what is GCF?

GCF is the relative centrifugal force,

and this measures the force which acts

on the sample during centrifugation and

is expressed in terms of multiples of G.

RPM or revolutions per minute is the

speed of rotation of the centrifuge,

or basically how fast your centrifuges moving

or the rate at which the rotor is revolving.

And the force applied to the contents will

vary by the size of the centrifuge rotor.

That means bigger rotor will have a different

RPM compared to smaller rotors.

It can be given by this equation 1.2

into 10 raised to minus 5 multiplied

by the rotor radius multiplied by

revolutions per minute squared.

When we talk about centrifugation or

filtration, what is the choice?

How do you choose whether to use

filtration or whether to use

centrifugation in a downstream processing?

So generally centrifugation is much

more expensive than filtration,

but sometimes we do not have a choice.

For example, filtration is

often very slow and difficult.

In such a situation we

will choose centrifugation.

Or sometimes,

if you want the cells or you

want the suspended matter to be

obtained free of filter A or to be

obtained free of any other matter,

then we will choose centrifugation.

Centrifugation offers a continuous

separation with a high standard of hygiene.

So sometimes in filtrations

we are not able to maintain

high hygienic conditions.

In which case we can choose centrifugation.

Let us look at Centrifuges

used in batch centrifugation.

Now what is the meaning

of batch centrifugation?

So in batch centrifugation there

will be a certain volume of liquid

containing suspended matter and

this entire volume of liquid will

be passed through a centrifuge.

It will be separated.

Suspended particles will be

will be centrifuged out

at the end of centrifugation.

It is clean and the process

is repeated again.

That's why it is called as batch.

Now.

Basket centrifuge is one example

of a batch centrifugation which

is used in industry when we

look at a basket centrifuge.

It consists of a stainless

steel perforated basket.

That means this basket contains

perforation so it contains holes and this.

Entire perforated basket is

lined with the filter cloth.

This entire basket is allowed or is

made to rotate at a very high speed.

Your product which you need for

centrifugation is inserted or

it's put into the basket and

when this basket is rotating

the product gets thrown outwards

due to the centrifugal force.

Now the solid particles get stuck

or they remain on that filter

cloth while the liquid gets forced

out through the cloth through

the perforation of the basket

and is collected outside.

The solid material remains on

the filter on that filter cloth.

At the end of centrifugation you

will remove the cake from that

filter cloth and you can wash the

cake if you desire the cells,

or you can collect the liquid

and process it further.

So this is what a basket

centrifuge looks like.

This will be the contents of the

basket in which you will put your.

Liquids and suspended particles

to be separated.

You have a filter cloth which

lines the basket and this is

your perforated basket.

This is your contents.

Then this entire basket centrifuge

spins your liquids get thrown out

and they will be collected outwards.

The cake which is formed will be

formed on this fate of cloth.

Basket centrifuges are used quite

often for separating crystalline

drugs like aspirin offer,

removing unwanted solids from a liquid,

for example for removing precipitated

proteins from insulin or when you have

sugar crystals which are formed during

the formation of sugar to remove the sugar

crystals from the remaining mother liquor.

The advantages of a basket

centrifuge is that first of all,

it is a compact structure,

so it occupies very little floor space.

So in industry floor space becomes

a big constraint, so baskets enter

features being small and compact,

they are quite often used.

It can handle a high proportion of solids,

so including slurries or

paste like consistency's.

All these can be separated from the liquid.

The final product that you get as in the

suspended particles which are collected

end up with a low moisture content,

so a lot of the water gets thrown

out of that perforated basket.

So your sludge or the cells which are

collected have a lower moisture content

and this process can be quite rapid.

But the disadvantage on the other hand,

is that it is a very labor intensive process,

being a batch centrifuge.

We can only centrifuge a certain

volume at a time.

So every time that volume

gets centrifuged again,

you have to remove the filter cloth,

clean it, load it again.

So these become very labor

intensive procedures.

And due to this continuous centrifugation,

there is a lot of wear and

tear on the equipment,

especially if you are going to use that

machine over a prolonged period of time.

Alright, now let us look at

continuous centrifugation.

So in industry the disadvantage

of batch of batch centrifugation

is that only limited volumes of

liquid can be centrifuged at a time.

However, in a continuous centrifugation

there is no constraint on the volume

of liquid that is centrifuged because

every time the centrifuge works,

the liquid is collected out.

Similarly, the solids that are

that are centrifuged will also

be separated simultaneously.

So these central features can work

over a period of time continuously,

and they can centrifuge large volumes

without putting off or without

stopping the centrifugation process.

The first example of a continuous centrifuge,

which we'll be looking at,

is the disk stack centrifuge.

At this disk stack,

as the name suggests,

consists of several disks,

and the discs are stamped.

That means they're layered one on

top of the other with very small

distances of about oh point 5 to 3

millimeter distance between them,

and the discs are placed or the

design of the disk is such that

the angle between the center and

the disk is about 40 to 50 degrees,

and this helps to facilitate the solids.

Each get transported on the surface

of the disk to the side of the pole.

So whatever, if you see this picture here,

these are your layered discs.

The distance between these discs

is very small and the angle is

40 to 50 degrees with the center.

So any solids that get separated or

that get stuck on the disk due to

the angle of these discs that are stacked.

The solids will have a tendency to get thrown

towards the edge or towards the

periphery of the centrifuge.

The feed is passed through a central tube,

so this is where the fluid comes in.

When you apply a very high centrifugal force,

the liquid gets thrown out onto these discs.

Now all your solid particles get

collected over here and due to

the force of centrifugation they

are pushed towards the territory,

while the lighter or the less

dense fluids remain over here and

these fluids are separated or they

are removed from the outlet.

The solids which get accumulated

are collected from the sides and

the cells or solids get separated

continuously from the exit here.

So every time the centrifuge fluid comes in,

this continuous process keeps

separating the clarified liquid

as well as the sales and solids.

So there is no collection of solids

or cell mass within the centrifuge

because it is continuously removed

via the central features working.

The disk stack centrifuge is are

used very often for deep watering

and separation of algae and water.

So when we are growing algal biomass,

if we want to separate the algae and

later if the algae have to be harvested

and want to remove the lipid layer

from the algae again these structured

centrifuge to remove the lipids

from these structured algal cells.

Disc centrifuges are also used

in in the dairy industry if you

want to separate with green from

the rest of the dairy product.

The advantage of a disc centrifuge

is that it can be used for

clarifying liquids that have a small

proportion of suspended solids,

and it separates the solids and

liquids in a continuous process,

so it's a it's a continuous centrifuge,

so you don't have to shut

off this interviewed by.

The process is going on.

Let us look at this second

kind of centrifugation,

continuous centrifugation process,

and this is the decanter centrifuge.

Now, as the name suggests,

the decanter centrifuge consists of

a fast rotating horizontal bowl,

so this is your horizontal bowl,

and if the whole bowl rotates very fast,

the design of the bowl is such

that it is tapering on one side.

The solids the whole entire

solution is allowed to enter

into this decanter centrifuge,

and when the fluids get inside

this entire horizontal bowl is

rotating within that horizontal

bowl there is a scroll or a screw.

Now the scroll is also made to rotate,

so there are two rotating objects here.

One is the screw which is inside

and the outside horizontal bowl.

The speed of rotation of the screw and

the horizontal bowl are different.

When the fluid gets inside the

scroll or this horizontal scroll

will rotate in such a way that all

the solid particles will be pushed

towards the tapering side of the.

Centrifuge and these solids and cells

or whatever solids are there when

they're pushed towards this tapering side.

They will be collected at the

bottom of the centrifuge.

Simultaneously,

as the scroll is rotating,

the solids get collected at this end,

while the liquid which is free

from the cells and solids,

get collected at the other end

of the decanter centrifuge.

So there are two exits again

in this Decanter 1.

Exit is for the separation of the

cells and the second exit is for the

separation of the clarified liquid.

Decanter centrifuges are used to

concentrate fluids with a high solid

concentration as opposed to the disk.

Establish centrifuge which has

which is used for separation of

a low solid concentration liquid.

Here decanter centrifuges can

even separate solutions where

the biomass is up to 80%.

Users of a decanter centrifuge

are very vast in industries.

Decanter centrifuges are used

to separate solid materials,

for example, in wastewater treatment

they are used in protein recovery.

They can be used in the recovery

of plant oils like olive oil,

vegetable oil.

Very often decanter centrifuges

are used in the separation of

distillers dry grain solubles.

Now this is a product which is formed from

Ethanolic fermentations involving grain.

We also use decanter centrifuges if

we want to clarify either fruit,

choose vegetable juices and it is

also used in the dairy industry

for the recovery of lactose or

whey fines, cheese fines, etc.

The advantages of a decanter centrifuge.

The decanter centrifuges have

a clean appearance,

very little odor problems

are associated with it.

They're easy to install,

and they require a small area for operation.

You can change the length of the

cylindrical bowl and you can also change

the cone angle for different applications.

The device is simple to optimize and operate,

and decanter centrifuges have very low labor

costs compared to other kind of centrifuges.

That is the end of this session.

So at the end of this you should

be able to understand and answer

the following questions.

What is centrifugation?

You should know what is.

You have to be able to describe any

centrifuge used for batch separations.

How does a disc stack centrifuge work?

Or what is a basket centrifuge?

These are the references students

you can have a look.

That will be all for this session.

Thank you.