Course on Industrial Biotechnology
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Lecture 19
Overview of The Fermenter

Now welcome back again the industrial biotechnology course. Now slowly slowly we are entering the into the main topics because now I am going to discuss about the overview of the power metres. How the fermantants looks in the industry and fermantants is a crucial part of any fermentation Industry that and which gives our desired product.

And let me let me tell you again that main advantage of the biochemical process as compared to the chemical processes is that biochemical process one particular compo organic compound can produce n number of products where where in the chemical process as well as the product changes your substitute of the changes and another advantage of the bio biochemical processes that is operated ambient temperature and atmospheric pressure.

The one difficulty, its disadvantage of biochemical process is that most of the biochemical process will be (())(1:22) condition. But the chemical process we don't required. This is only the drawback that we have with a biochemical process.

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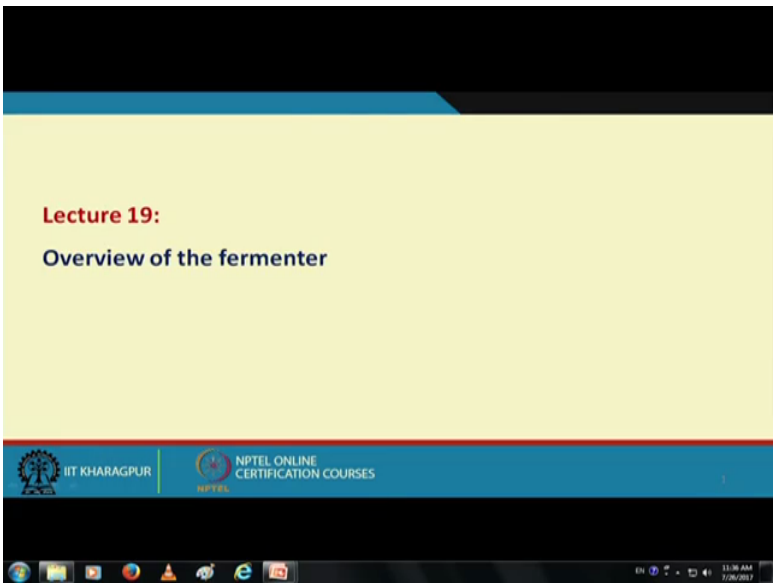

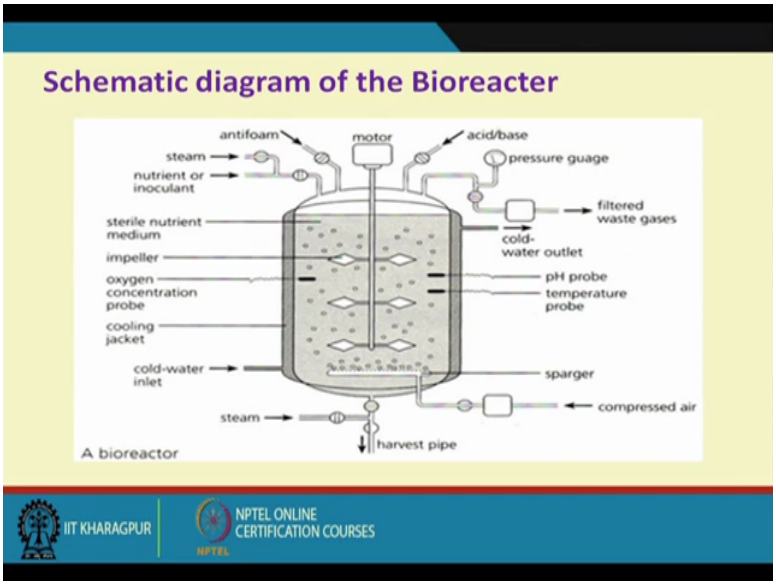

Now let me give you some view of the this process and this this is the schematic diagram of the bioreactor this I explain before also. I don't like to discuss this again. So only I want to show you that what are the major component is there. This is a motor is there is connected with impeller and main purpose is to start the liquid. What is the purpose of studying to keep the solubility homogeneity in the reaction mixture? I can give a typical example here.

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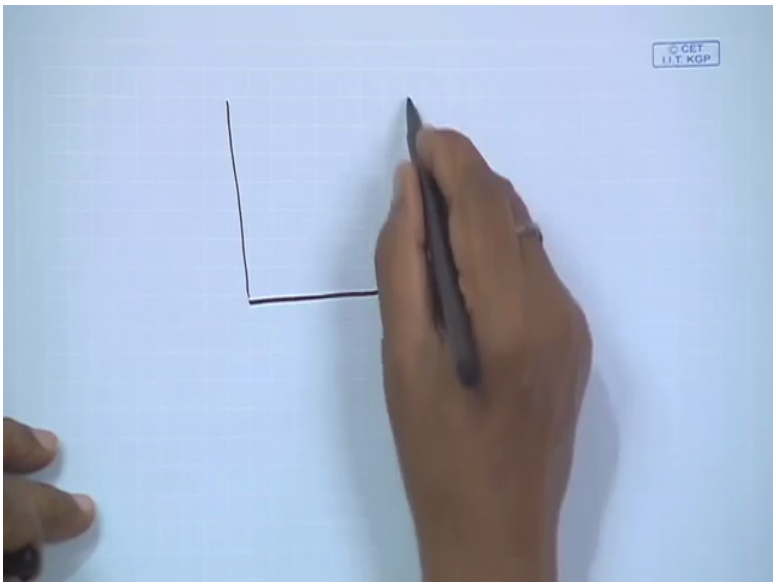

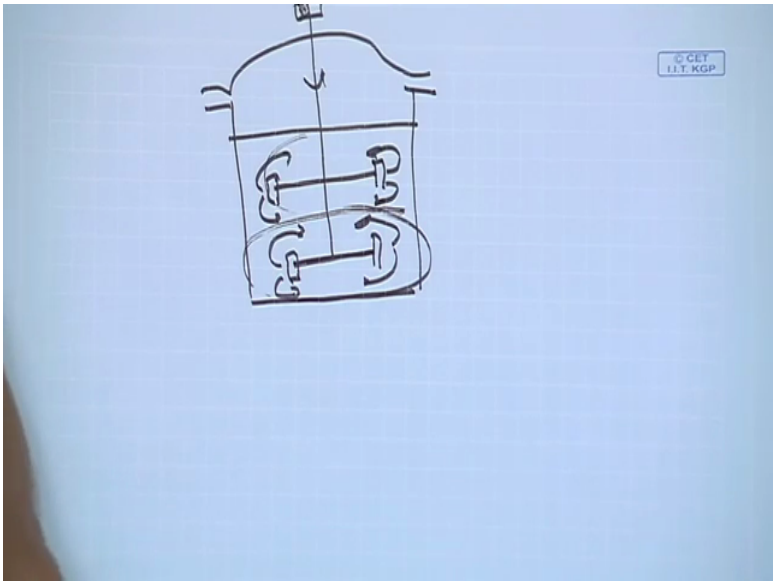

Suppose when there is a starting, the it will be start like this. So one thing I want to point out that when you have one one blade like this. It will it will only the (())(2:36) will be this portion, not this portion. So for this position (())(2:42) again you should have another plate. So that you know that there will be starting then. So there is a multiple arrangement of the blades. So here you can you can see hear that you have so many blades are there.

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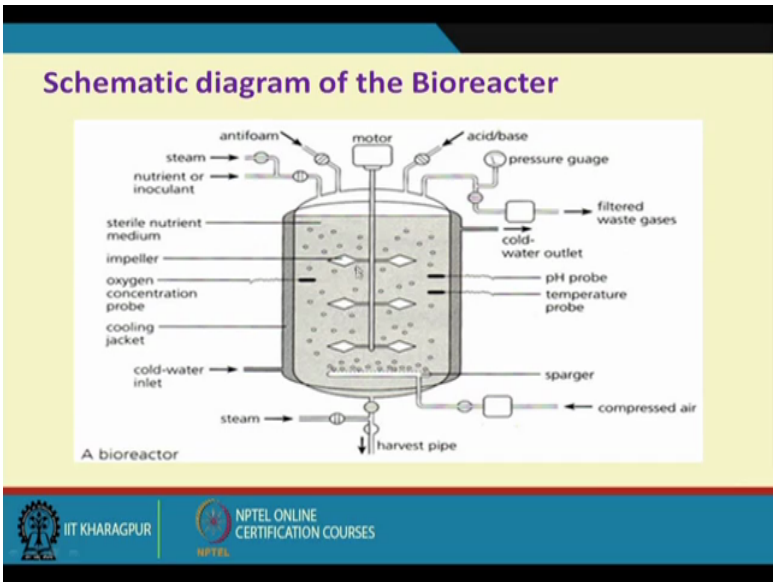

This is not a single and it means if analysis to have the homogeneity in the reaction mixture and plus we have we have this is Sparger, this is called a straight line air is required most of the bio-chemical industry. They are operated on the regular condition and I mention that organism that take the oxygen that is dissolve in the liquid, so you have to spot it. There is Sparger, different type of sparger are there.

Then there is the harvesting harvesting is very much required because after the fermentation is over we have to take out the media. How how we can take out the media? That the what we do you do? We have a (())(3:36) and we we close this Outlet valve and if you close this outlet valve then what will happen? There will be air pressure here. With this air pressure, it will drag the liquid through valve. This is usually the gate valve.

There should not be with their should be very little resistance here. This will take the material form in the formulation plant to the recovery plant means that you had the purification of the product take place. So we have to take this after the fermentation of of the process we have to take the material from there to this the recovery unit and you have to settle Adamant. We have we have some monitoring system.

We have temperature monitoring system, we have ph monitoring system, we have dissolved oxygen monitoring system. We put some kind of sensor here what you call antifoam sensor, who is connected with the antifoam oil tank. As soon as the foam touch the antifoam sensor, the pump connected with anti foam that will be energize and anti foam in the in the inside the formantant. So that your foam will be subside. So this is the couple of arrangement we to have in the fermentation industry.

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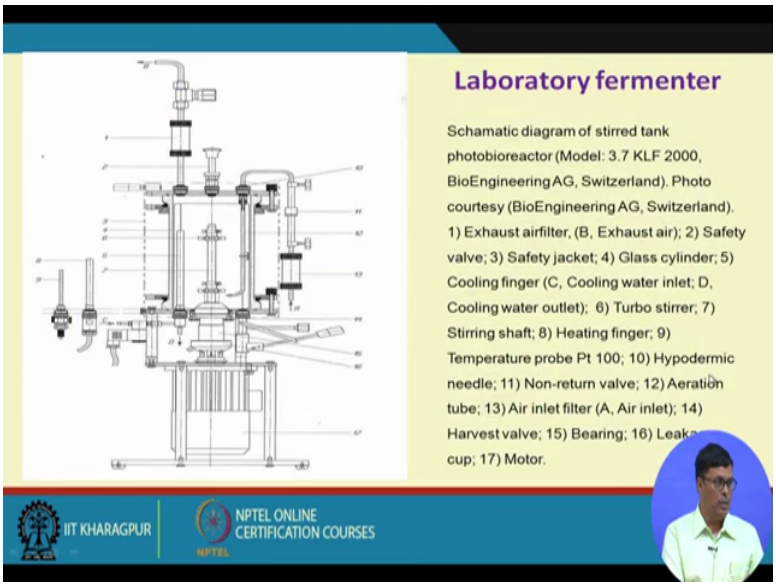

Now for before we to go in details about the industrial fermenters, we should have very clear cut conception that whatever lab fermenters have because this is in the basically that industrial fermenter is the replication of the lab formenter. Only some portion of that may be

modified but the 45 requirement we we have in the small reactor (())(5:23) requirement we have for the industrial fermenter. Now this is kind of simple example that we have.

Here you can see this is a Basil and this is there are different arrangement, this is called as air sparger. Can you see this is the filter air filter for sterilization of the air and then we go here. We go we put some kind of non return valve this is very much important because because because if there is the power failure then what will happen that that there is a possibility when liquid can come here and enter into the air filter.

Air filter air filter will be raptured and the contamination will take place. So for that we keep non return valve and this is the (())(6:12). This slat is little bit different from the normal wrote that you have we should be perfectly straight because it passes through with mechanical seal and mechanical seal is a very important things that we have in the fermentation industry because one is the moving part another stationary part. So possibility that air can enter through the system.

So that air can go inside the system. Then here we have some heating arrangement. In the industrial level we do it in different way we have some Mysore show you how we maintain the temperature in the industrial fermenters then in the exhaust seal see that we have a condenser hear. The main there is a air filters then this is connected to the condenser. Why you put the air filter?

The reason is that so again there if there is if you have power failure that air can go enter into the fermenter enter in to the fermenter then again contamination of the format will take place and that causes the that that will affect our fermentation process to a great extent. So there this is the temperature monitoring system what you call thermostat and then that we have this is the safety what you call pressure regulator valve that you know that as as soon as as soon as that pressure increases to a great extent that this is blocked.

So that no hazard take place inside the system so this is always we have safety valve because this all we have in the industry and this is the motor for the operation of the this fact that we have the Motor and other things that we have.

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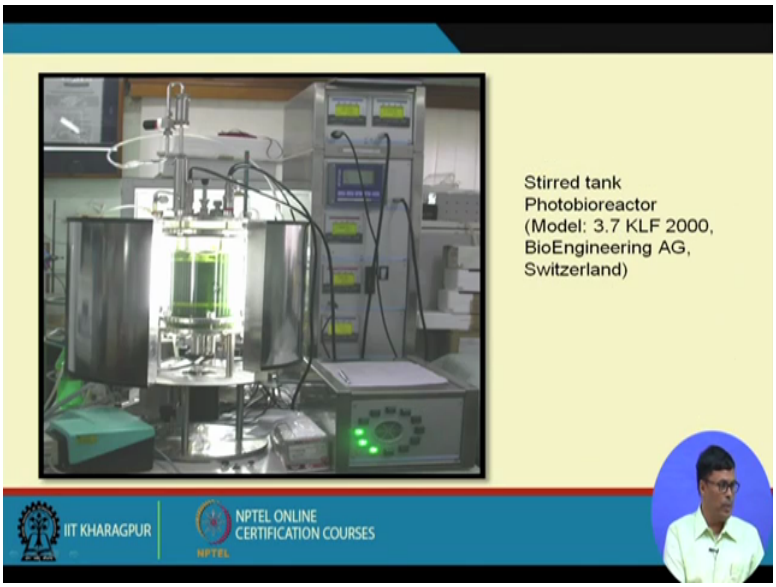

Now this is the bio engineering fermenter that is in operation in my in our lab. You can see this is the control control module. Where we can monitor different parameters live. We can monitor temperature, we can we take admission paid, then ph of the Seasons, dissolved oxygen concentration all this thing you can monitor this process that you have different monitoring system that we have here.

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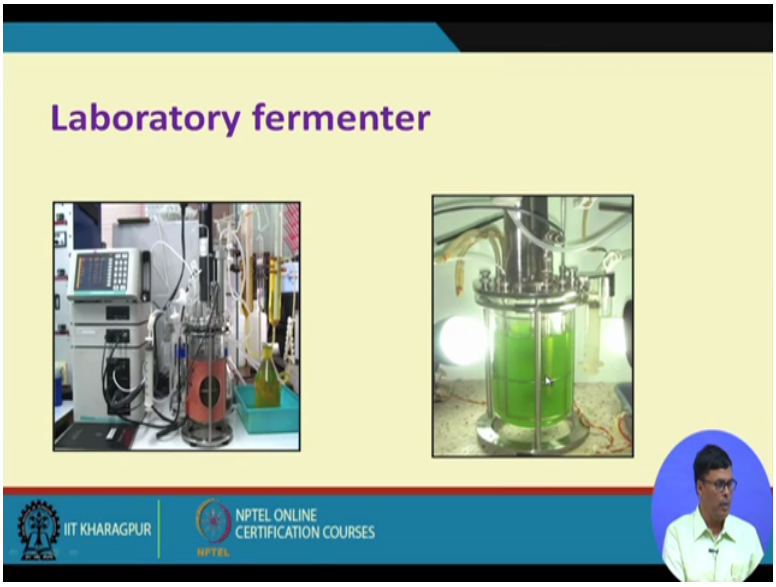

And this is another fermenter we have. This is New Brunswic fermenter that also this is the control module control module and this is the this is the fermenter that we have different parameters that is we stayed here you can easily visualise that what are the values of the

different diameters and online you record every moment the change of the parameters which is very important for our research purpose and this is how the fermenter look. In the small fermenters small fermenter small fermenters.

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Now you can see that this is a high glass that is one we have a eye glass this side another we have this side. Then we put some light here, so that the other side we can visualise what is going on in the system

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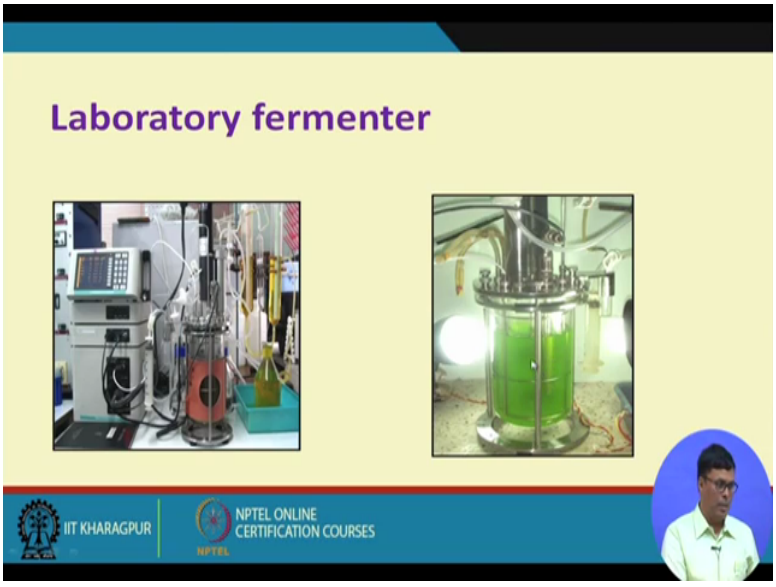

Because if you if you look at our lab fermenter this is made of glass, so you can easily see from outside for what is going on inside the fermenter.

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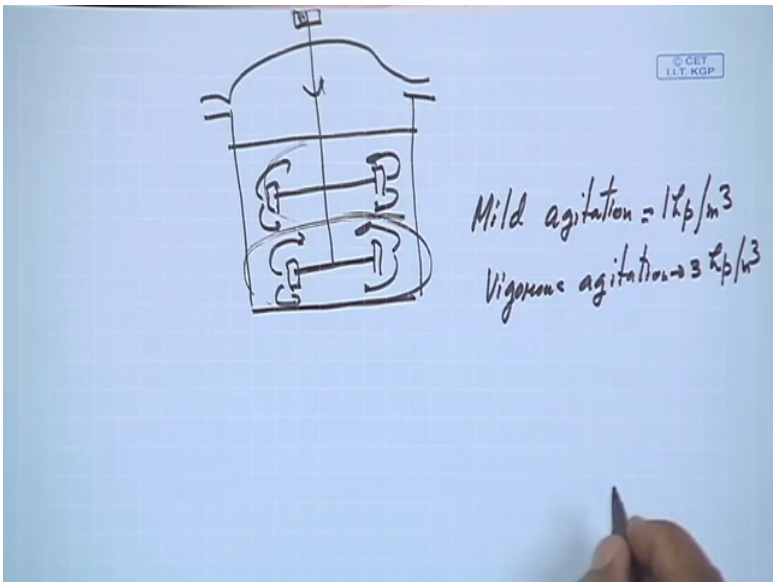

But in case of industry this is the the material of construction is mostly the stainless steel and so we can not visible from outside. So you can you can have the watch glass through the watch glass you can visualize that what is going on and this is the easy treated and this is the mechanical scene that we have.

Now here I want to point out that that that you know that power requirement is more (()) (10:11) because you know that mild agitation we have mild agitation and vigorous agitation. The mild agitation power requirement approximately 1 HP per cubic metre volume of the reactor and this is about 33833 more than 3 HP that the per cubic metre volume of the reactor. So you know that about 2223 that in a higher higher that you know power required.

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Now as I told you I work with citric acid industry and our capacity of The vessel was 200 cubic metre so that the power drawn by the power required but the is it it was around 200 HP is very high very huge amount of power we usually apply. So this and this power if you directly applied to the sat we can imagine what should be the velocity of the visitation speed will be driven the size. So what you what you do for first we put put the power in the gearbox.

In the gearbox we step wise reduce the speed and ultimately that whatever will speed we won't be transferred into this particular sat. So you know whole gear box that is usually submerged in the in the antifoam valve tank because this valve actually that because when I if we gear they are connected with each other and there they have tremendous friction and due to friction it will it will generate lot of heat and the you know you know oil has fire point.

If you allow you to increase the temperature after sometime that it will catch fire. So what we have to do that you have to take the oil out and pass through the cooling system again again heated recirculate in your gear box so that you maintain the temperature. So this is very much required to run this is this is applied in the industries.

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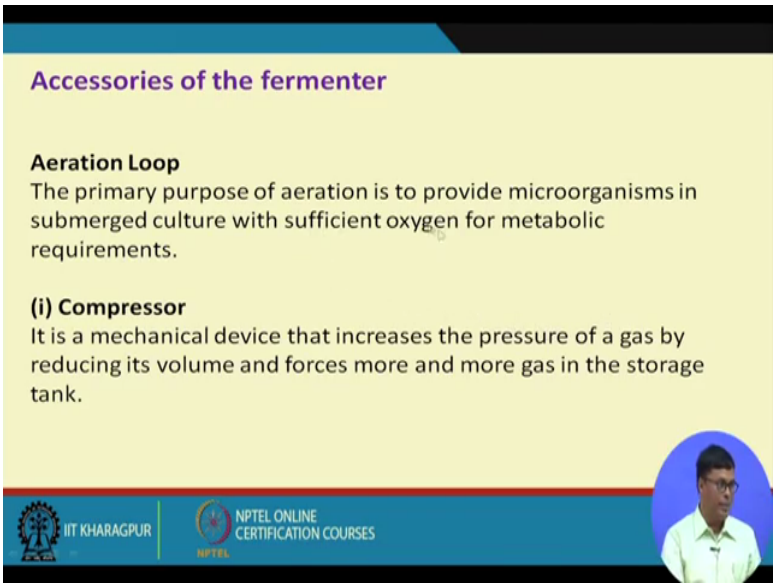

Now let me discuss the accessories of the fermenter which is very much required. The aeration loops that the purpose of education is to provide the microorganism is submerged cultured with sufficient oxygen requirement because this this this oxygen is supplied with the help of compressor. Compressor it is a mechanical device that increases the pressure of the gas by reducing it's volume and force more more and more gas in the storage tank.

So we can pass as per our requirement. We pass the compress air through the air filter, air sterilizer then we pass it to the to the to the fermenter. The this is very much required this vision has to optimise. It depends on the mass transfer coefficient of the system and the flow rate of the air that is usually determined with the help of Rotameter.

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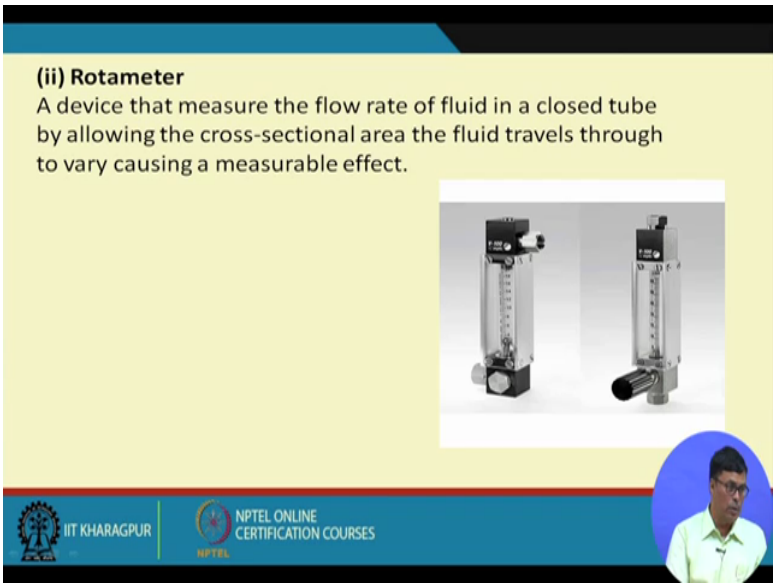

Rotameter looks like this. You can see in the rotameter they have a linear scale. This is a linear scale. And there is a float. This is a small ball you can see when when air comes in it will as they should increase this this ball will float move and go up and up. It is a device that measured the flow rate of fluid in a closed tube by allowing the cross-sectional area of the fluid travel through to vary causing the measurable effect.

So whenever we use any kind of Rotameter, first we shall have to remember you should have to calibrate the Rotameter because any kind of meter that we use for any any any fermentation industry so we shall have to calibrate first. Calibration means whether the reading that is showing that that is in the in the meter whether it is prepared or not that you have to find it out. So you have to how you can get you can calibrate that? With the help of gas flow metre, with gas flow metre with gas flow metre you can find out what is the flow rate of here. So we know then you can you can find out this is like this.

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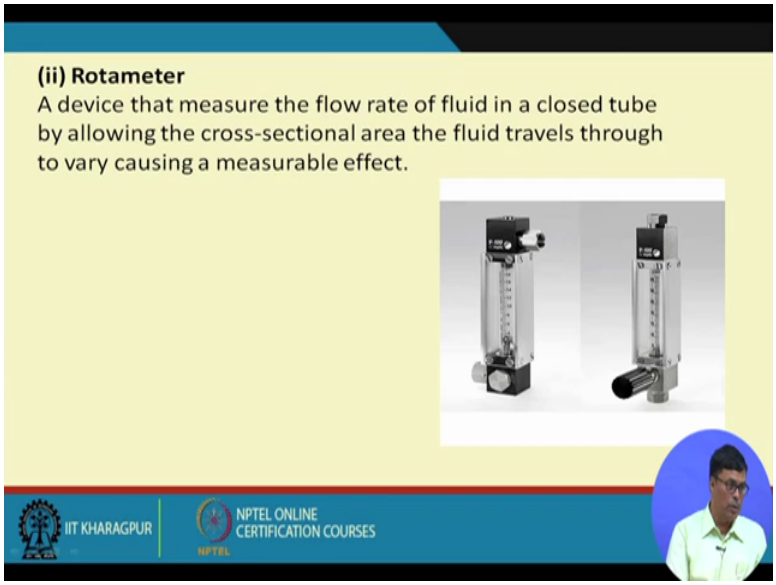

So we can plot this flow rate and then you have linear scale. The li this I want to want to say this is the linear scale. Now suppose if you here this is zero this is maybe up flow rate. You can you can you Can have the 1 litre per minute, this might be two litre per minutes, that 3 litre per minutes like this you can have. So you have linear scale also your value is changed like this. So you have you have like this you have linear scale like this.

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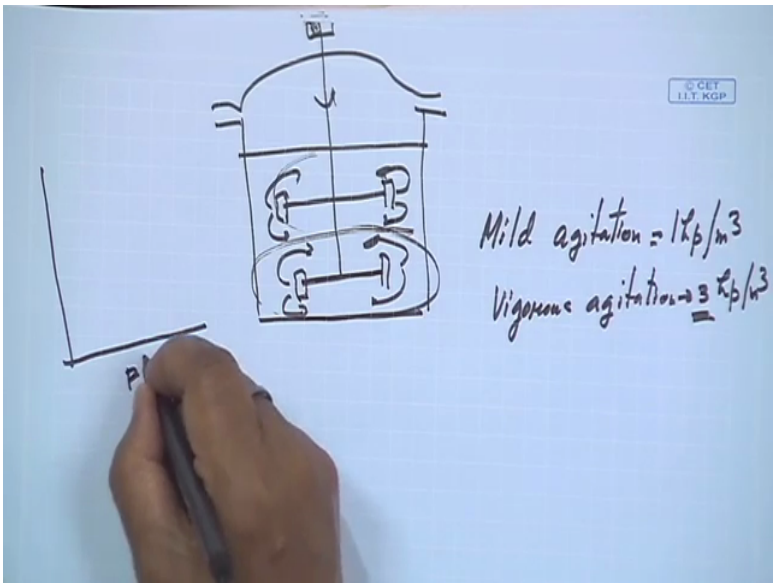

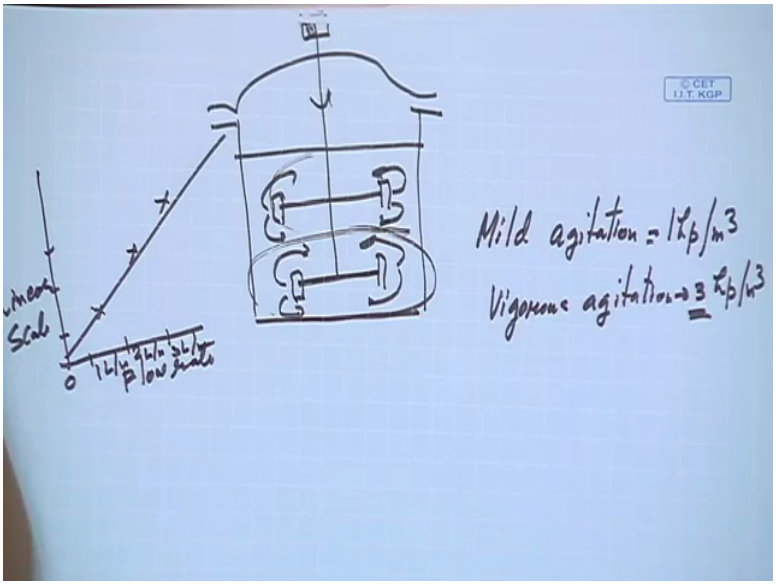

So So from that when you when you operate that you suppose it is here, so formed if you have this calibration curve, you can easily find out what is the actual flow rate of the air so rotameter is largely used in the fermentation industries to find out the flow rate of the air.

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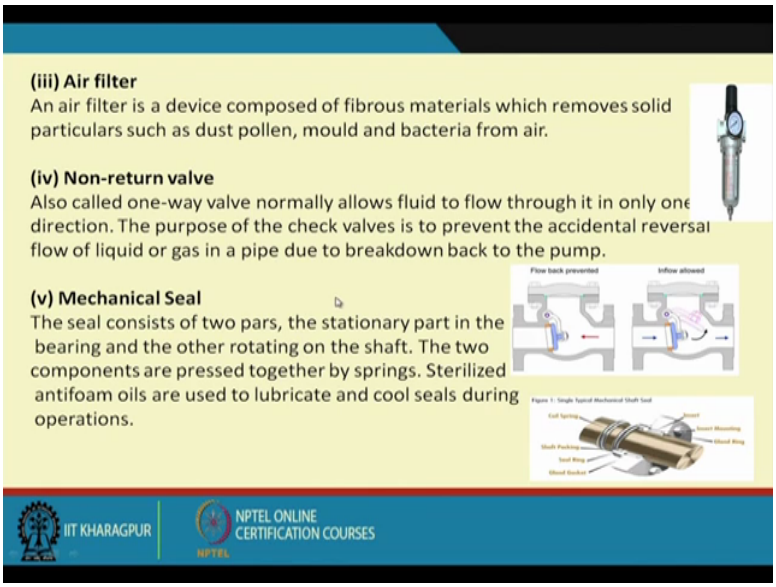

Now in the chemical Industry that you know here I want to point out that for the flow rate of the gas will have the very high flow rate we use different type of flow metre. What you call venturimeter and orifice meter those are the different type of flow metre that we use in the chemical industry when we have the very high flow rate.

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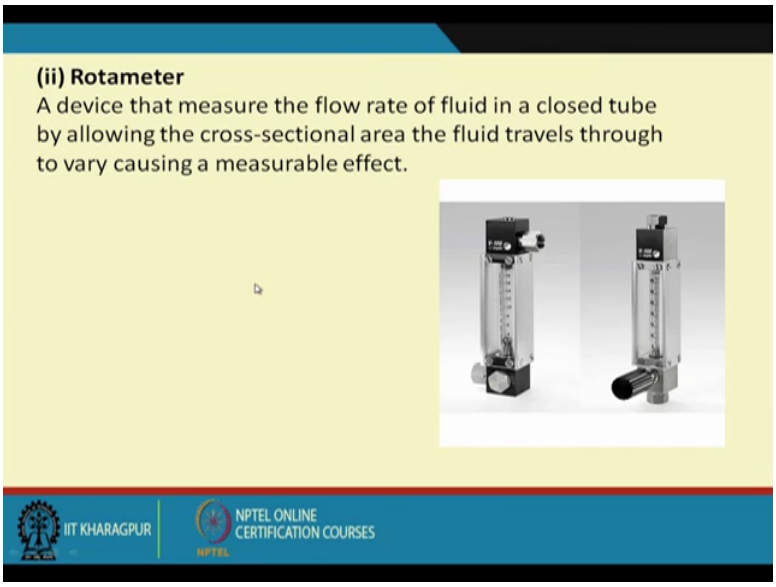

Now and then we have the air filter. air filter is the device composed of fibrous material which remove the solid particles from the dust pollen, moulds and bacteria from the from the air because this is very important because you know in the fermentation Industry that that air air contains lot of particulate matters and particulate matter where the career of the

microorganisms. If you if you don't take out this particulate matters from the air then what will happen?

It easily enter into the process in to the liquid. I need the in the in the media is content with this this particulate matter discount in the cell, you can contaminate the system so you have to remove it. Now I said this is there for the removal we use the kind of filter because we but this is kind of different type of filters we use particularly glass wool fiber we use for the removal of the pollutant present in the particulate matter present in the air. (())(17:23) so this I shall discuss in details when I shall discuss the upstream processing that I have taken into consideration both air sterilization.

And medium sterilization. So next is the non return valve because non return valve looks like that that you can see that the liquid can prove this detection if it full of Direction This valve can open and this is this is but if it this this way valve cannot be open and I told you this will be really we keep it in the air air in flow line because why we can do we put in the air flow line because if there is a power failure there is any possibility the liquid present in the media present in the fermentent.

Then we will go go back to the system. So that is why to stop that we should have non return valve. The non return valve also called one way valve. Normally allows the way to flow through any 2 only 1 only one direction the purpose of the check valve is to prevent the accidental reversal flow of liquid or gas in a pipe due to bring and break down back to the pump. So it will happen for disable break down also it can be happen happen. Next in the mechanical seal, I told you the mechanical seal plays very important role in the fermenent.

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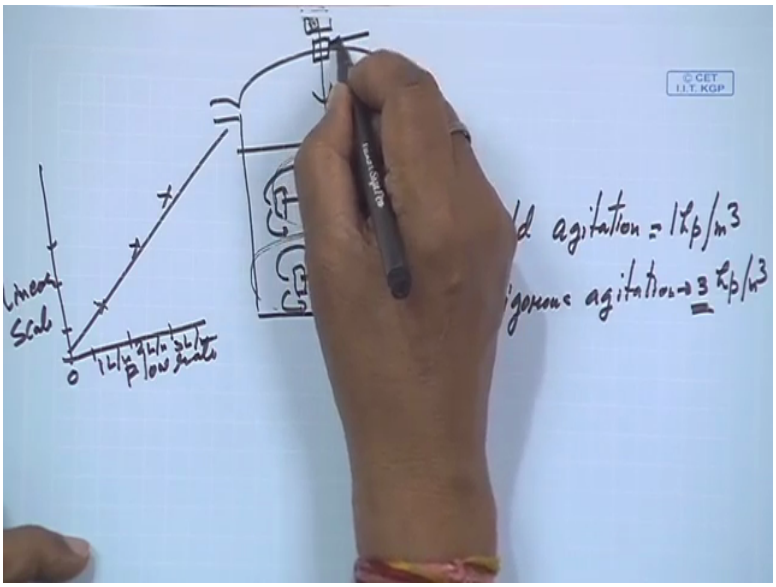

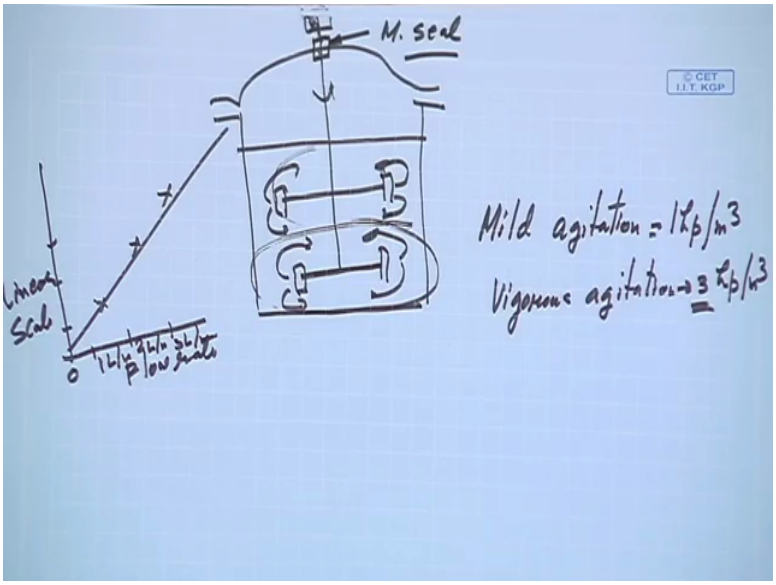

Because here in the is it is here we have this air this this connection between the motor and this sag was the outside this is we have mechanical seal, m seal. This is the mechanical seal that we have.

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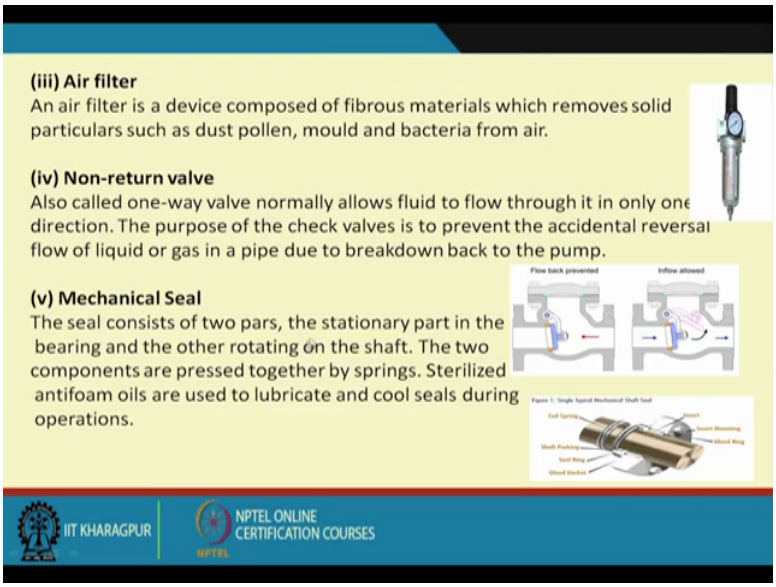

So mechanical seal consists of two part this is the stationary part in the bearing and the other is a rotating shaft. So this is one is stationary and the rotating.

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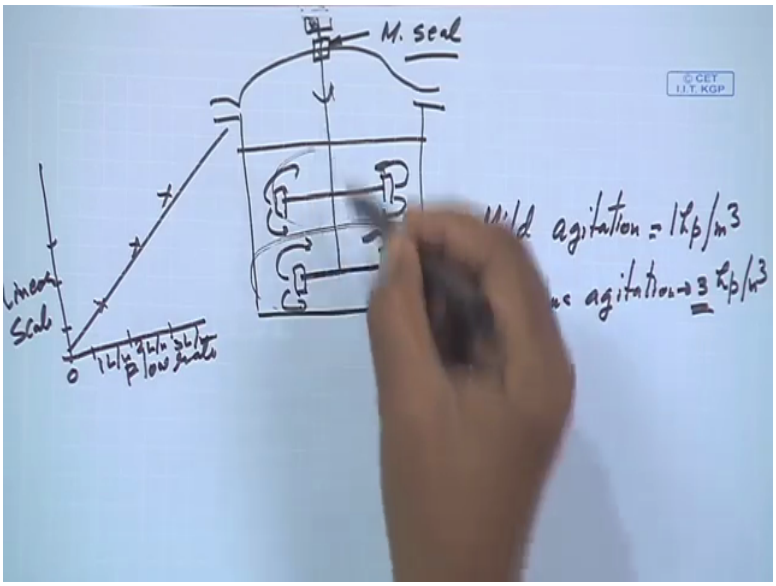

So this is stationary because you see that when you talk about the mechanical seal that is stationary this is fixed. And then your sat is going inside that is that is moving that is mobile part. That is the other is rotating sat. The two components are placed Together by Spring and sterilize anti foam oil are used to lubricate and cool the cell during the operation. Now there's bury they are tight like this and at the same time.

Because if you cannot try it maximum because the reason is that if you if you tight very high then the friction will be behind and if there is a fiction then no friction mode will be heat generation and if the heat generation is more it made after the mechanical seal. So what we do in the industry we pass the anti foam oil.

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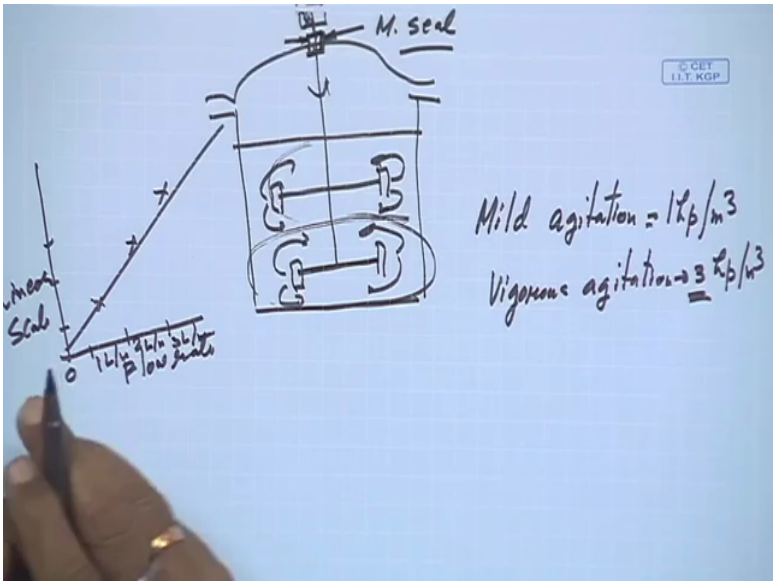

So here we pass the anti foam oil at the high pressure. So when you pass the anti foam oil at high pressure it maintain positive pressure inside this air mechanical seal in there is a positive pressure inside the mechanical seal what will happen?

There is a least possibility of air to enter into the system and this is how we can maintain the sterility of the process and main purpose of the passing the oil to do the lubrication of the sat. It will do the lubrication of the same then fictional force will be reduced and if the frictional force is reduced then the heat amount of heat generation also will be reduced to a great extent.

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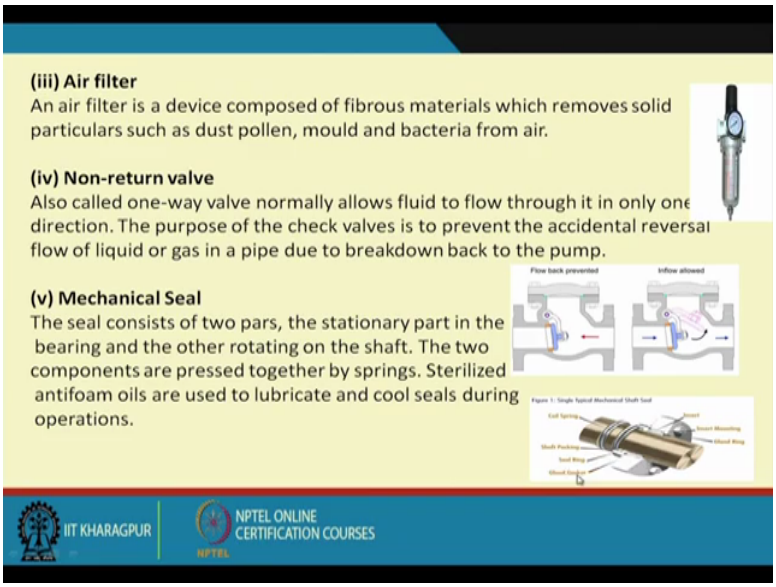

Mechanical feel you can see that industry whole different type of packing materials they put inside and this is this is only few company in the world they can produce that this kind of mechanical seal what the fermentation industries.

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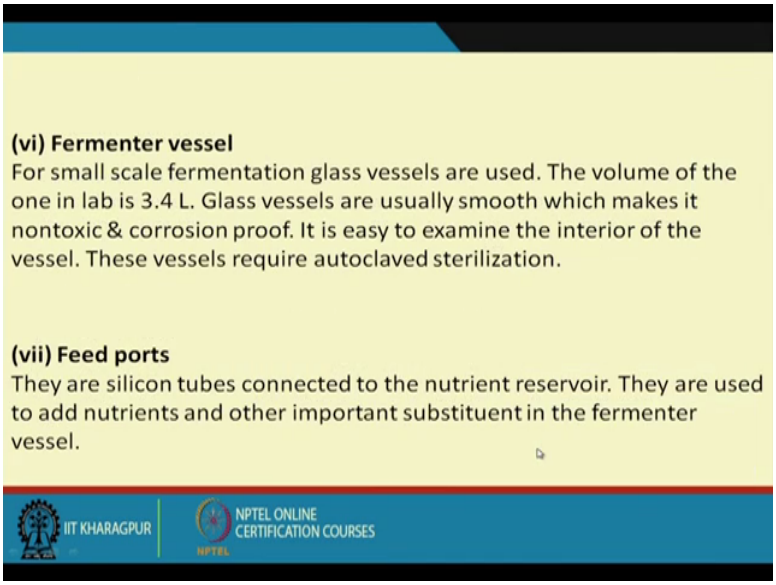

Then fermentation vessels formentation vessels I told you in the small format that we usually made glass vessel so that we can see outside with the industry we use the we use stainless steel because stainless steel they can resistance the high acid concentration because most of the fermentation process we produce lot of organic acids and organic acid some kind of caustic effect on the materials of construction.

So we discussed before that how the material how the composition of the alloy Steel stainless steel that affects the improve the acid resistance of the property of the stainless steel. So we can have that is why stainless steel is used in the fermentation industry. It is easy to examine the interior because here we use the glass vessel in the in the lab fermeneter to examine the vessel.

The industrial fermenter we use I told you we have the watch glass at the top of that by the help of light we can find out whatever what exactly what is what is going on in the inside the system. Then we puts we had here in the in the in the in the lab fermenter we use the silicon tube for for for transferring the liquid form inside the format for the industry which we have some stainless steel pipe line through which we had the nutrients to the fermentation transmitted to the fermentation. So this is the (())(23:04) that we have.

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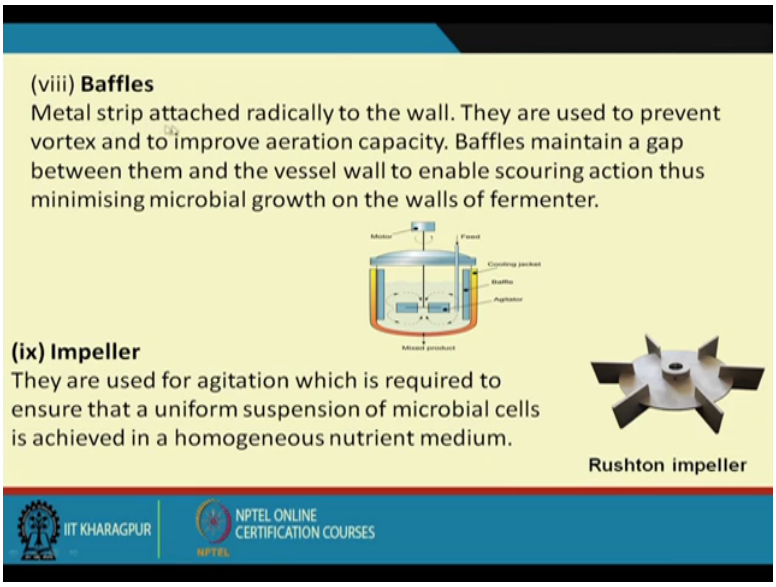

And the baffles which is very important baffles in the metal strip at is radially to the wall and they are used to prevent the vortex and and to improve the aeration capacity. Baffles maintain a gap between them and the vessel wall to enable scouring actions scouring action thus minimising the microbial growth on the walls of the once of the fermenter. We explain that.

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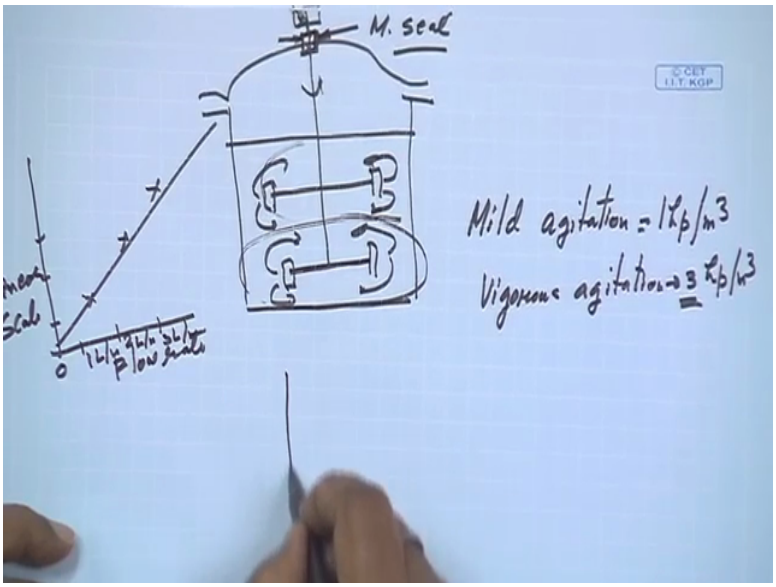

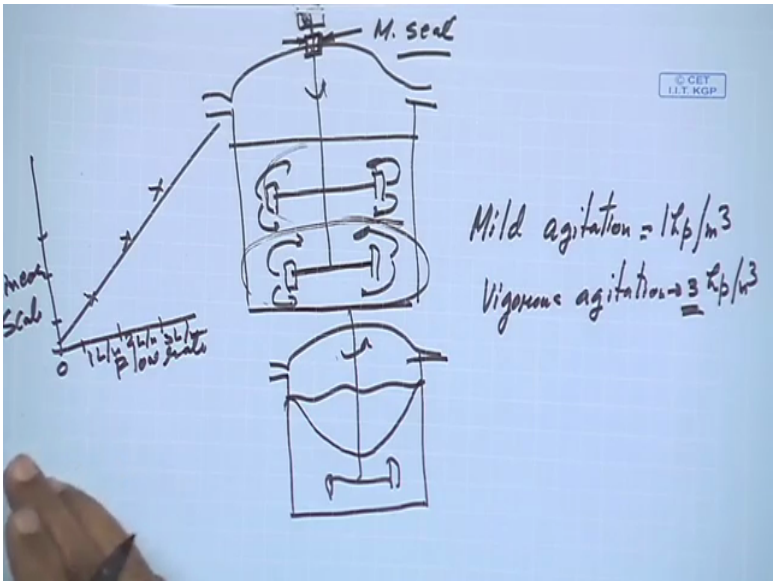

Suppose this is a fermenter and this is a fermented Sant. We put indicator here. So if we if we if we if we don't put any (())(23:54) then what will happen there is a vortex formation. This is like this we can we can see in the in our house also. when you take water in the glass and put the sugar in it and try to make a solution with the help of a spoon then we'll find there is a vortex formation like this. Now now if you do the eration here then what will happen?

What is the problem that air that that goes like this. Air is going bubble will go like this the bubble will travel like this. The since here the height is less the return symptom of the bubble with very less here and it in (())(24:34) of bubble will be more that is undesirable. So in the industry this this label should be as it is. So to do that what you do?

We put a back here this is the back on with the metal strip that will put (())(24:49). So that if you put the stream then know there will be no vortex formation. So this is the baffles that you have here you can see.

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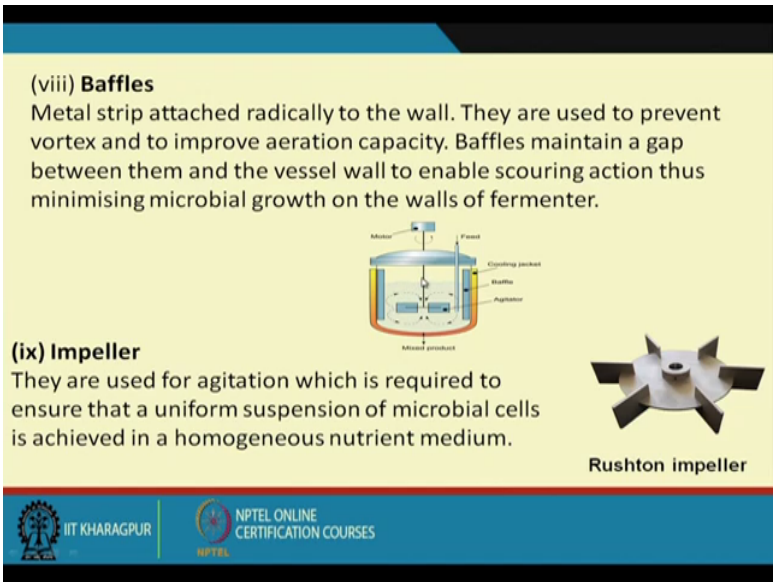

This is the baffles we have in the in the reactor. This is how how the liquid is remaining that is m at the same level there is no vortex formation here. Now impellers that is very important and they are used to it and I already explained you that how the impellers? What is the function of the impellers? You need to sure that uniform suspension of the microbial cells is achieved in a homogeneous nutrient medium. Now here I want to point out you can see this is a disk am I right?

And it is connected with the different blades and you have the number is there 1, 2, 3, 4, 5, 6 so this number you can you can make it 5 you can make it 6 maybe 7 whatever then I work with the industry then I find that way I told you will have to keep the that you know that this simple it that played in the different levels.

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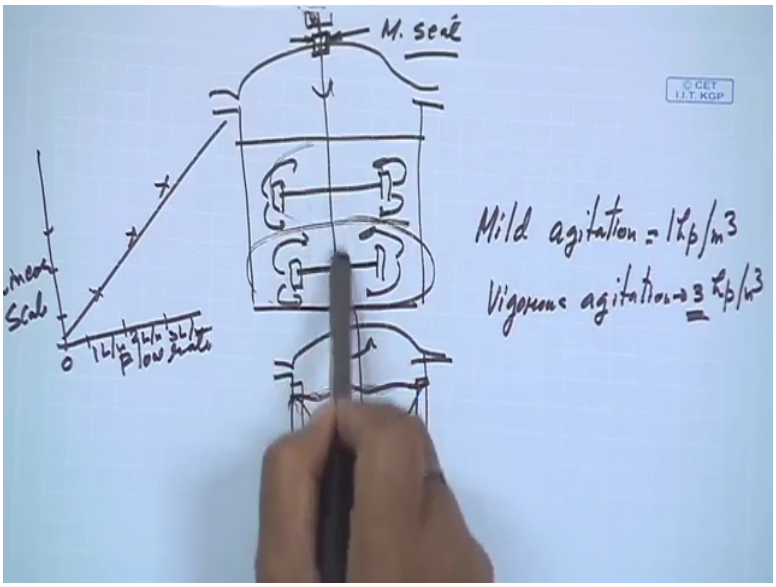

This one because height is more then then you have to you have more baffle across the (()) (26:11). You should have to put in the fix with the with the sat. Now now this number of this plays very important role because we find this this number is not optimised but it remain that's great that the fermentation of the fermenter.

So the industry try to optimise that which combination we can have the minimum vibration in the fermenter. So that if there is a lot of vibration in the fermenter this problem is undesirable because otherwise that the again some (())(26:47) of the connection will be losen and configuration problem will take place.

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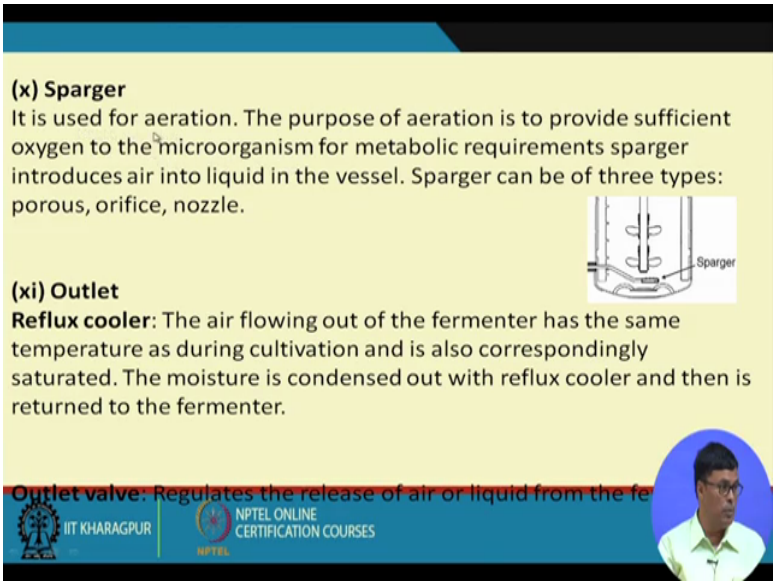

Then we have sparger can see that is used for additional purpose. The purpose of variation is to provide the sufficient oxygen to the microorganism for metabolic requirement. Sparger introduce air into the liquid of The vessel. This is this is here you can see that air is coming like this and sparging like this like this then Reflux cooler this is actually this is fitted in the outgoing stream of the air because the if you allow the air to go out of the reactors.

Then when we pass through the reactor then air will be saturated and then slowly slowly you will find the volume of the fermeter will go down because if you now if you if you want to return the value of the same then there should be condenser at the exit of the of the air airstream so that you can condense the vapour into the reactor again so that your volume will remain constant.

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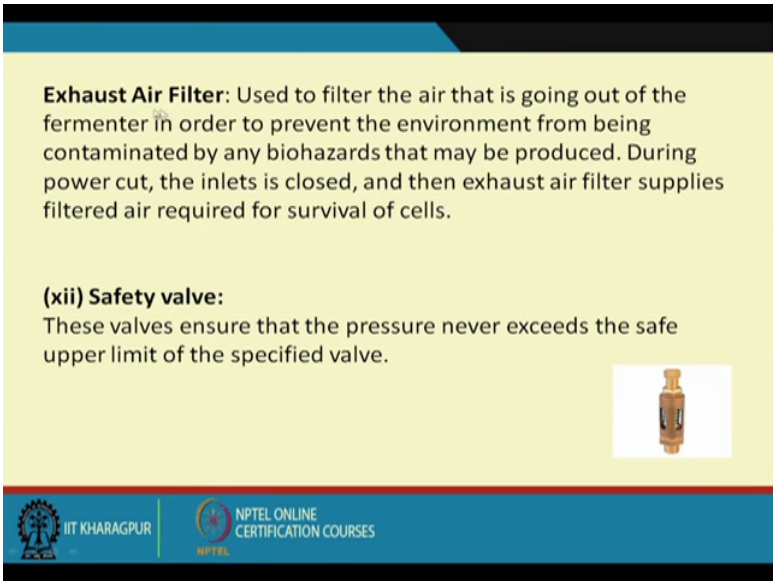

Now this is the exhaust air filter I told you this is just to stop the contamination problem we have in the existing safety valve is very much required because if they did some other reason the pressure inside the reactor increases there is a possibility of hazard that will take place. that we have we know that in our regular use in the home that if a pressure cooker we have a safety valve because same in the industry also we required the safety valve for the safety measurement.

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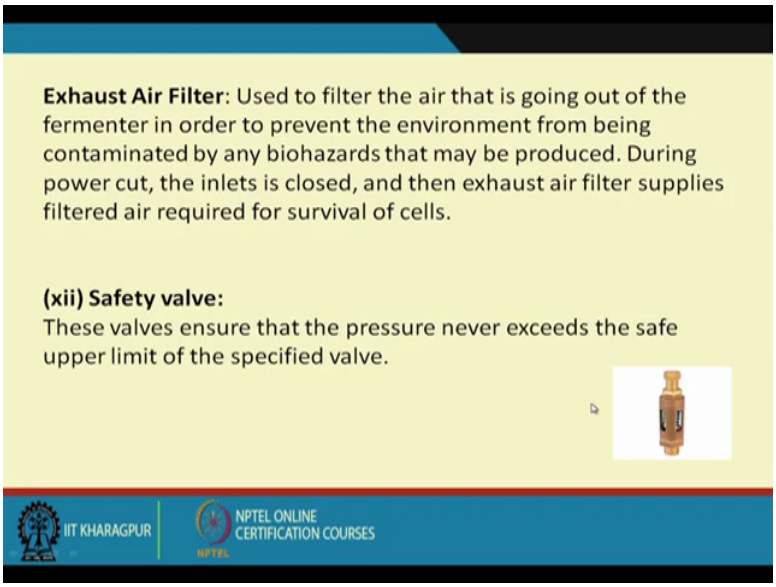

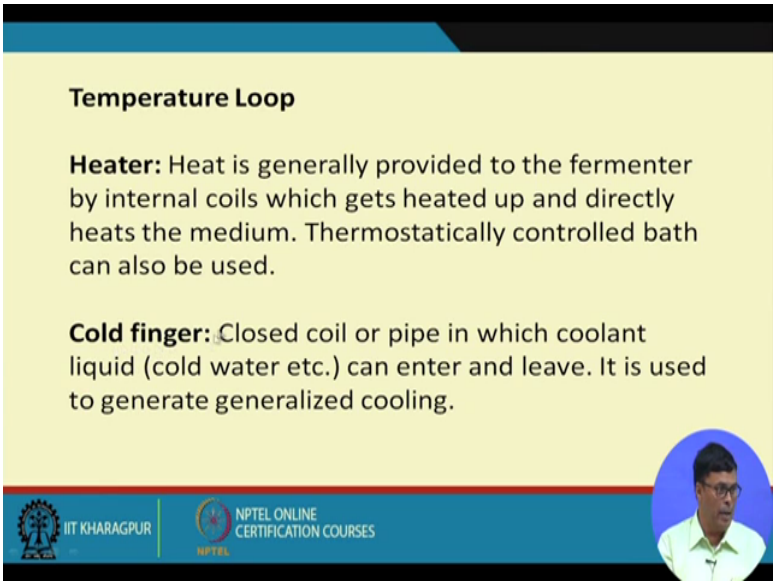

Then we have the temperature too. We have heater and pulling finger that that cooling heater because I can I can tell you that in the fermenters we we usually put the jacket where it is jacket it and we pass the water like this.

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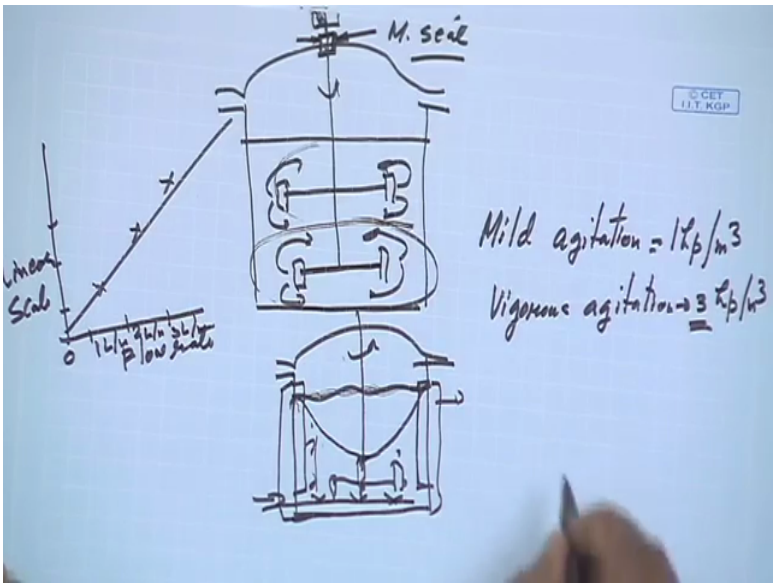

Now if you do this there is a possibility of channelling effect. So what I do in the fermented basically that we have we have pipeline. They wrap on the surface of the fermenter like this. So we we we pass this pipe line across the fermenter like this. So that water goes uniformly through the surface of the (())(29:06) and it has some kind of cooling effect.

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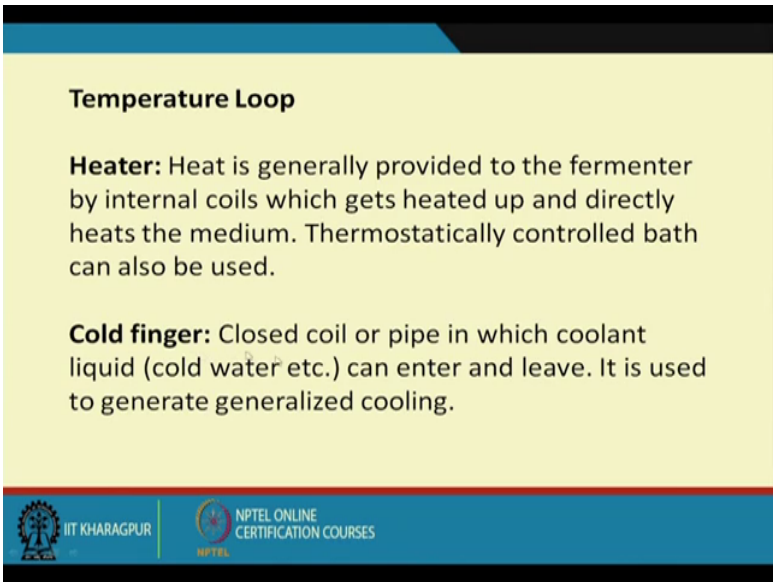

So both the cold water and hot water we can send through this as per requirement.

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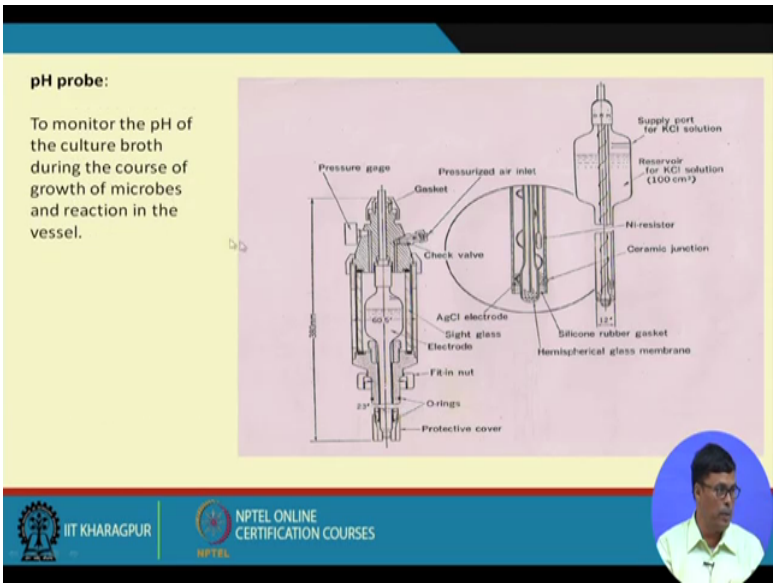

This is the ph probe used in the fermenter which is different type as compared to the normal ph probe. You can see that because when this this we use inside the fermenter disc beast and the 15 PSI pressure because the usually the sterilization take place that 15 PSI pressure and if you if you because the facility is that we maintain some pressure is here 15 PSI with the help of hand pump we can we can do that.

This is the show that you know if we don't maintain the pressure then what will happen? The fermenter they they inside the produce glasss the liquid can enter and affects our electrolyte and damage the system. So avoid that. We should have some kind of pressure here above the electrolytes you should have 15 PSI pressure so that no such damage can take place. The special device that we have in the fermenter for the ph Pro.

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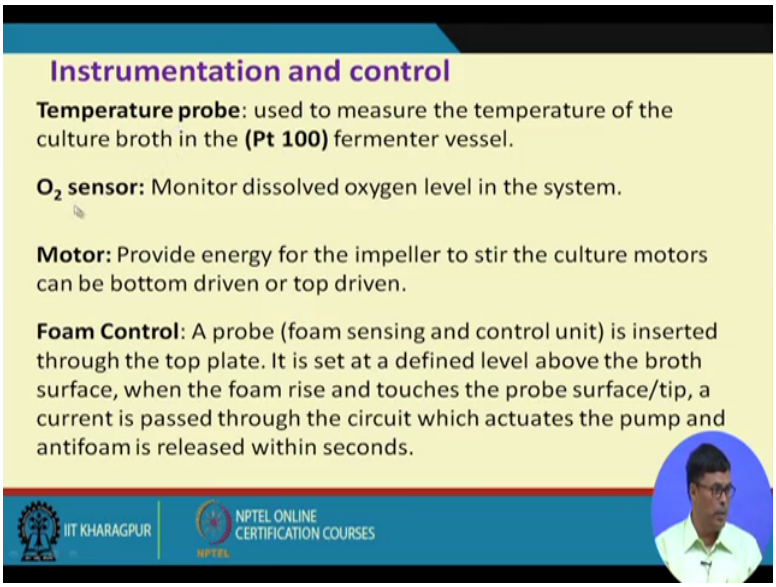

So this is the principles and temperature probe also their oxygen sensor also motor and probe controlled device already discussed. Thank you very much!