Introduction to Machining and Machining Fluids
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Lecture - 19
Biodegradation Studies of Cutting fluids

Today we are going to study about one of the important concepts of cutting fluid, how we can test the Biodegradation of various cutting fluids?

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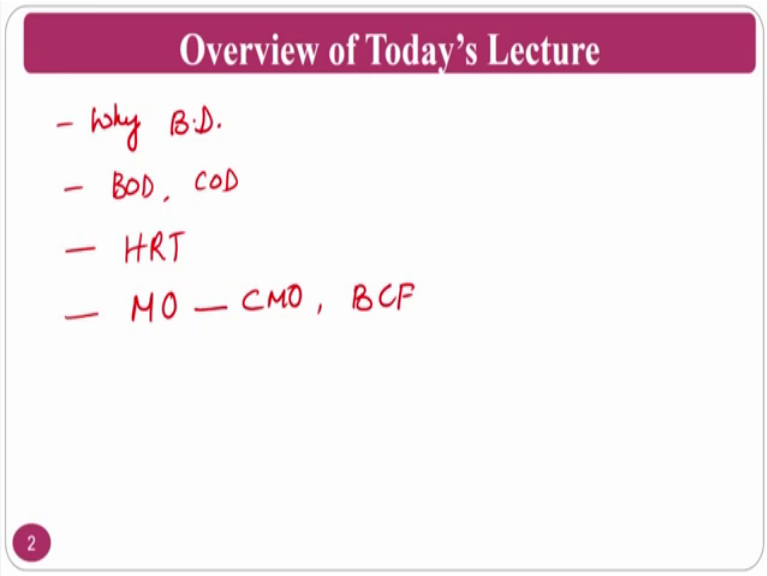

Overview of today's lecture we will see why the biodegradation is important and what is BOD and COD and all those thing biological oxygen demand, chemical oxygen demand and all those things. We will see also what is HRT hydraulic retention time and we will see what is ammonia and nitrites, nitrates in the form of the one of the forms of the cutting fluid, how it is going to effect the operator as well as the environment and all those things, we will see in this one biodegradation.

So, at last we will compare with respect to mineral oil in some of the places we also say that it is called as a CMO that is called commercially available or the commercially mineral oil, commercially available mineral oil or commercial mineral oil and we will compare with bio cutting fluid, how these will effect and all those things we will see?

So, on an average we compare the biodegradation studies of commercially available mineral oils such as servo cut s is what we have used. And some of the alternatives mineral oils are available by servo itself and Hindustan petroleum some many many companies, which are supplying these types of mineral oils.

Bio cutting fluid which is also we have taken in this studies a (Refer Time: 02:13) commercially available bio cutting fluid.

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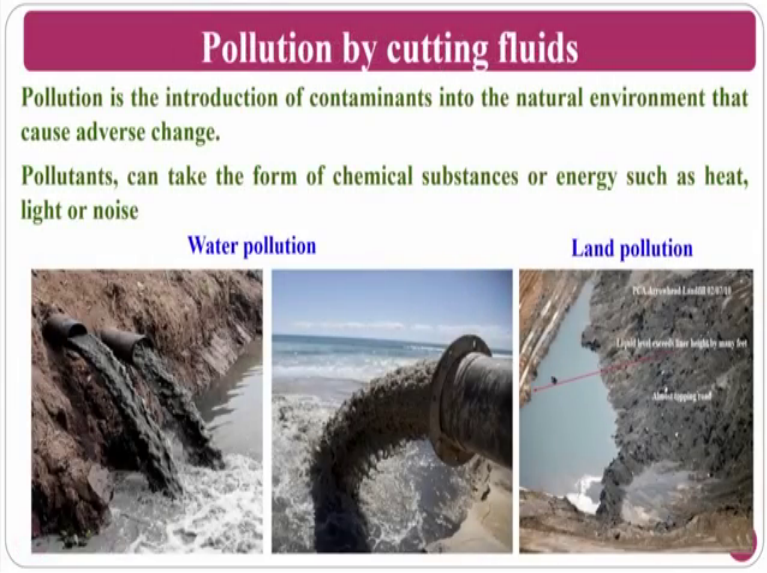

So, comparison study we will see. So, pollution by the cutting fluid if you see the pollution normally in the emissions chapter, when we are studying there is a problem on the system plus surroundings the surroundings, what we are going to deal today; especially from the point of water pollution which we are going to study today ok.

The pollution is introduction of contaminants into the natural environment just whatever the contaminant that in the daily life one come across, if you are we just releasing into the normal atmosphere that is called pollution pollutants came from chemical substances or energy such as heat light or noise and all those things.

So, currently what we study about in this particular lecture is about chemical substances. If you see the picture the figure 1 and figure 2, figure 3. So, these 3 figures the figure 1 and figure 2 shows, how the pollutants are polluting the water pollution or the nearby water bodies?

And this is a drastic effect and if you, if somebody do or some companies do it is a unhealthy practice from the point of marine as well as the people who are living surrounding to the those water bodies.

The third one is which we have seen also in the cutting fluid emission that is called land pollution or soil pollution. So, if you just dig into at certain part of a company at some corner and just to dump the cutting fluid this is you just throw it on a open land wherever, which is nothing or nobodies land or it is it if you on a public land or something. So, it will cause us lot of land pollution or the soil pollution.

Mostly today's lecture revolve around the water pollution.

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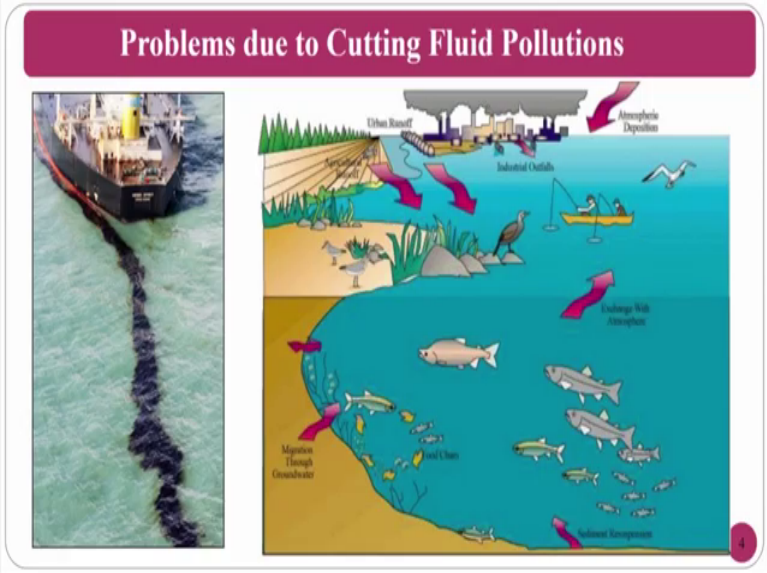

If you come across problem due to cutting fluid, if you see the cutting fluid or petroleum based some of the fluids which you can see in this figure 1. So, cutting fluid or some of the mineral oil it is it is mixed with the normal water body and it contaminates as well as, it will affect the complete marine acquire system; like fishes, prawns, those organisms that live on these one like birds and all those things if you see in the second picture. So, these are all the system marine system that will effect on it ok.

So, one should take care about what should be released and what should not be released that is what we will see. If you release before it is it has if you release those things, which are dangerous to aquas life; obviously, it will create lot of problems to the aquas

life not only to the aquas life it also destroy or create problem to the people or the organisms or any other living things that will depend on those aquas systems.

So, it is not a good practice to release these type of things.

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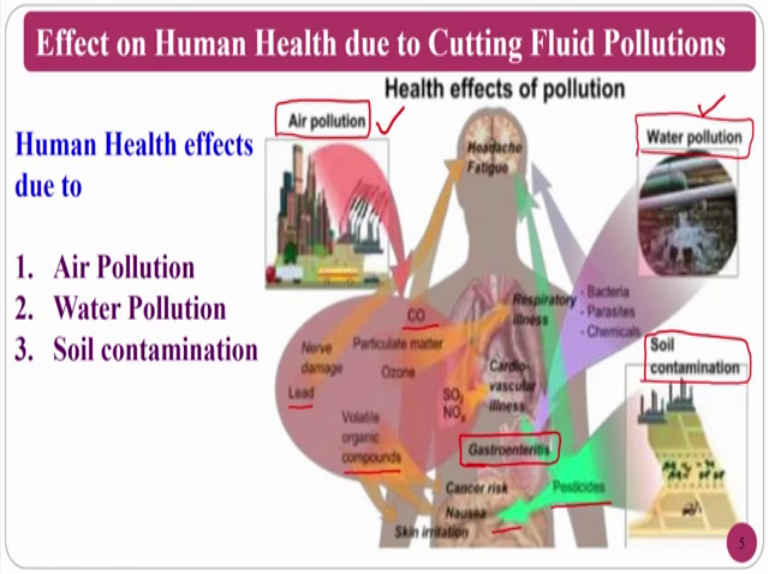

If you see the human health effect normally the air pollution, water pollution, and soil contamination, how these are going to effect the human? If you see the air pollution this is the air pollution this is going to affect in the nerve damage from the point of lead, volatile organic compounds it will create lot of cancer, skin irritation and all those things and another carbon monoxide these are the things that will pollute the atmosphere and causes lot of problem to the operator.

If you see the water pollution how the water pollution the water pollution, bacteria, parasites, chemicals these are all goes and destroy the gastroenterology system that is your stomach gastric problems, acidity problems, these type of problems also you come across ok. If you see the soil contaminations so, soil contaminations will create lot of problems like; cancer risk, nausea, and skin these are the some of the problems which you come across.

So, today's class since we have already seen in the previous lectures in the cutting fluid emissions chapter, there we have seen air pollution effects. Now we are going to see the water pollution and we do not have much problem or major issues with the land, because

land it contamination is the only slight problem ok. That will have it is own effects currently the second major that will be what we are going to see is water pollution, how this water pollution comes with respect to the cutting fluid and all those things we will see.

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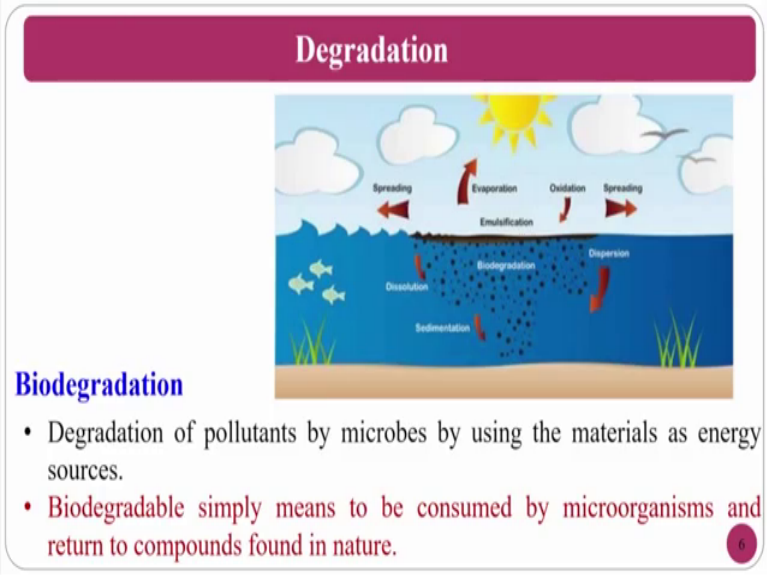

So, degradation normally there are many types of degradation is there some of the people you may be heard of hydrolytic degradation, chemical degradation is there biological degradation is there and all those things.

So, degradation means if there is any particular chemical or a polymer or any material is there it will degrade with respect to time, in any means like chemical degradation, hydrolytic degradation, biodegradation, many degradations are there.

For example, if you see I am continuously telling about the biodegradable polymers are placing it is own importance in the nowadays world, because it is starting from the tea cup to the bio implants. What is it will degrade inside the body? If you are putting the implant inside the body normally, it will also degrade assume that poly lactic acid is there it will degrade into lactic acid ok. That is one type of degradation.

What we are seeing today bio degradation is nothing, but degradation of pollutants or any substance by microbes using materials as energy of the source. So, that means, that

these microbes will take as it is one of the sources of their energy ok. Like Enzymes, Maine, Bacteria, virus, these are all are called as microbes ok.

Bio Debigrade biodegradability simply means it is consumed by the microorganisms and return to the compounds, which are found in the nature; that means these microorganisms just to take as their energy source like carbohydrates or something.

So, it will take and it will release another thing that are biodegradable are which are naturally found on the earth this is nothing, but the biodegradation.

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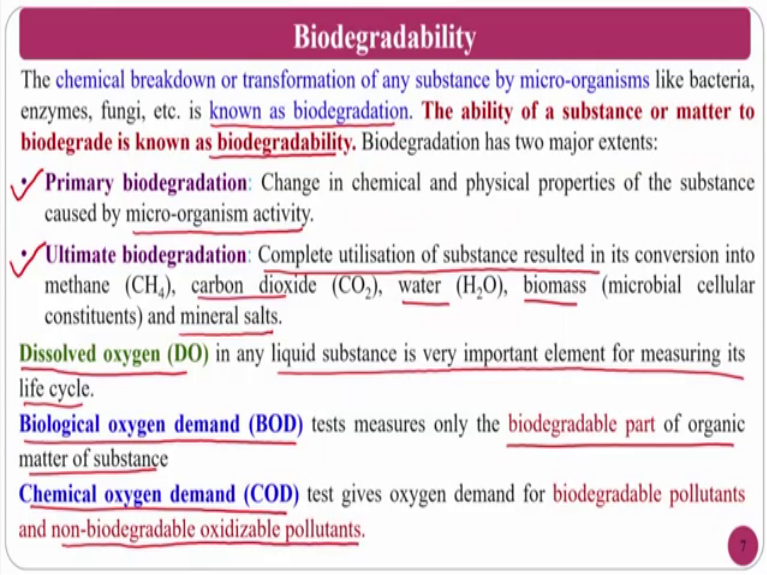

So, biodegradability the chemical breakdown or transformation of any substances by the microorganisms like bacteria, fungi are known as biodegradation ok. The ability of substance matter biodegradable known as biodegradability there are 2 terms, which are familiar with respect to biodegradability that is primary degradation, another one is ultimate biodegradation it. So, primary biodegradation deals with change in chemical or physical property of the substance caused by microorganisms activity.

So, ultimate biodegradation normally it is complete utilization ok. In the primary biodegrading we can see preliminary experiments only or preliminary biodegradation whether it is degradable or not. We can from that experiment, we can also expect it can be completely degradable or not only thing we can expect or we can predict, but ultimate degradation is the experiment that one has to conduct or you have to do some of the

mathematical calculations. So, that you can say quantitatively how much is biodegradable? Whether it is 99 percent biodegradable or whether it is ninety percent degradable or so on.

In the ultimate bio degradation complete utilization of the substance result in the conversion into methane or carbon dioxide, water and biomass as well as minerals and salt. You can convert into this type of things in the ultimate bio degradation. So, there are few terms that you should be familiar.

So, dissolved oxygen normally dissolved oxygen in any liquid normally it will contains, in any liquid it is very important element to measure it is life cycle, dissolved oxygen, oxygen will be there always in the liquid in the dissolved form. So, how the fishes survives their life and all those things you know the mechanism at the early stages of our carrier normally like 6 to 10th in between normally we study all these mechanisms and all those things.

The first term that I am going to give you is biological oxygen demand that is called BOD which I was explaining in the overview of today's lecture. It measures only the biodegradable part of organic matter of the substance, assume that I have a particular substance this BOD tells me how much e biodegradable part is there that is only it will says non-biodegradable part it would not deal with.

So, in the chemical oxygen demand that is the second one if you see here it gives oxygen demand for biodegradable pollutants as well as non-biodegradable oxidizable pollutants; that means, that COD deals with both that is biodegradable part and a non-biodegradable part. So, BOD deals with only the biodegradable part COD deals with biodegradable and non-biodegradable part.

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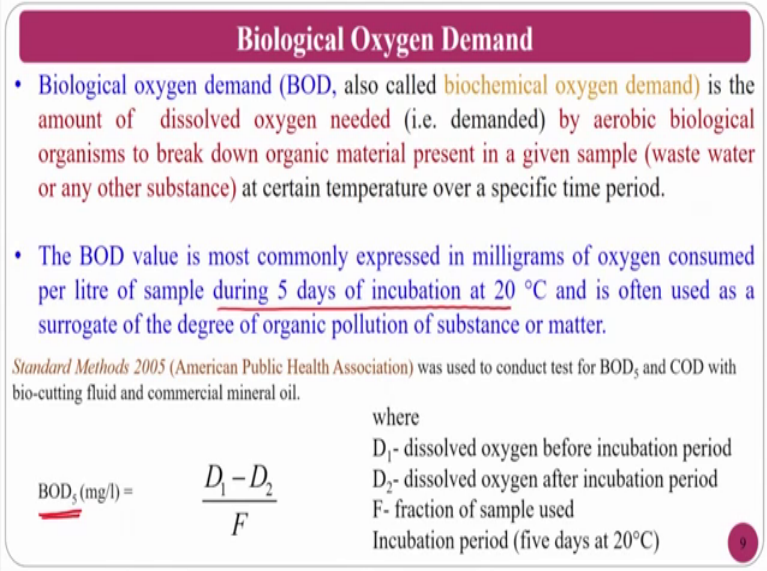

Chemical oxygen demand let me come for the first biological oxygen demand biological oxygen demand, also called biochemical oxygen demand this is amount of dissolved oxygen needed or demanded by aerobic biological organism to break down the organic material represent in a given sample, at certain temperature over specific time. That is how much oxygen I want or the dissolved oxygen I wanted to break or to degrade the biological part biodegradable part that is nothing, but the BOD value commonly expressed in terms of oxygen consumed per liter sample during 5 days.

There are 2 terms which you come across that is called BOD 5 which is a normally subscript will be there like BOD 5 that is nothing, but biological oxygen demand when a test is done at 5 days ok. During 5 days of incubation at 20 degrees, if you do that is called biological oxygen demand or BOD 5.

There is another term which is called BOD u that is nothing, but ultimate biodegradability that is biological oxygen demand ultimate there is another term which you come across. If you see here this biological oxygen demand, which you normally you measure in terms of milligram per liter.

So, D 1 minus D 2 by F which is D 1 stands for dissolved oxygen before incubation period D 2 is dissolved oxygen after incubation period fraction of the sample used in the incubation during the incubation period; that means, whenever I am using a system I will have the dissolved oxygen at the maximum, if I am putting my organisms or microbes

into the system this microbes will eat away or we will consume some of the oxygen from that source which you are putting.

So, your D 2 always will be less than your D 1, that and how much fraction of the sample you are using or microorganisms that you are using that you deal with.

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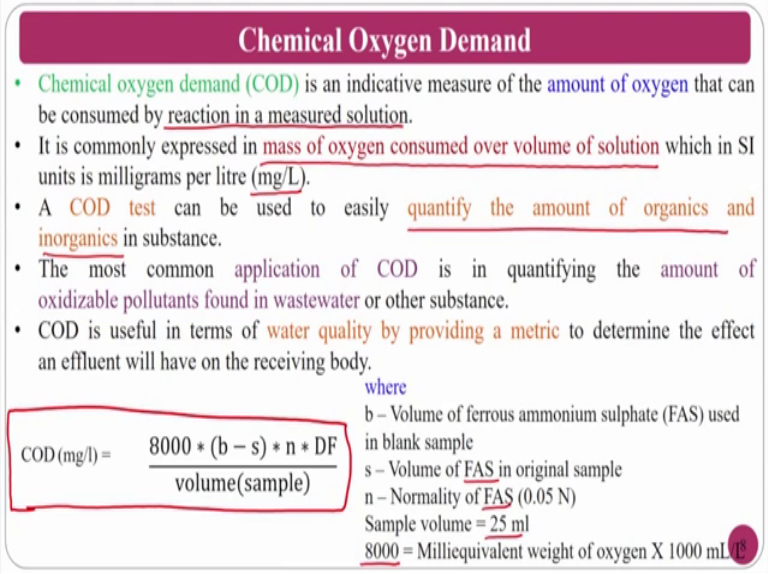

Chemical oxygen demand chemical oxygen demand is a indicative measure of amount of oxygen that can be consumed by reaction in a measured solution that is already I said it is a complete organic plus biodegradable plus non-biodegradable ok.

Commonly expressed in the terms of mass of oxygen consumed over a volume of solution this is also will be expressed in the form of milligram per liter COD test can be used easily quantified amount of organics and inorganic substances. So, you also I again I am stating that this will deal with degradable as well as non-degradable part.

The COD will gives the equation like this, where COD milligram per liter if it is 8000 multiplied by b minus s multiplied by n multiplied by D and F. So, volume of the sample is at the denominator, b is the volume of the ferrous ammonium sulfate in the sample s is volume of ferrous alum ammonium sulfate in the original sample n is the normality of FAS sample volume is 25 ml normally what we will take 8000 is the milliequivalent weight of oxygen multiplied by 1000 milliliters this is about the equation.

So, from this you can calculate the COD as well as you also know how to calculate the BOD.

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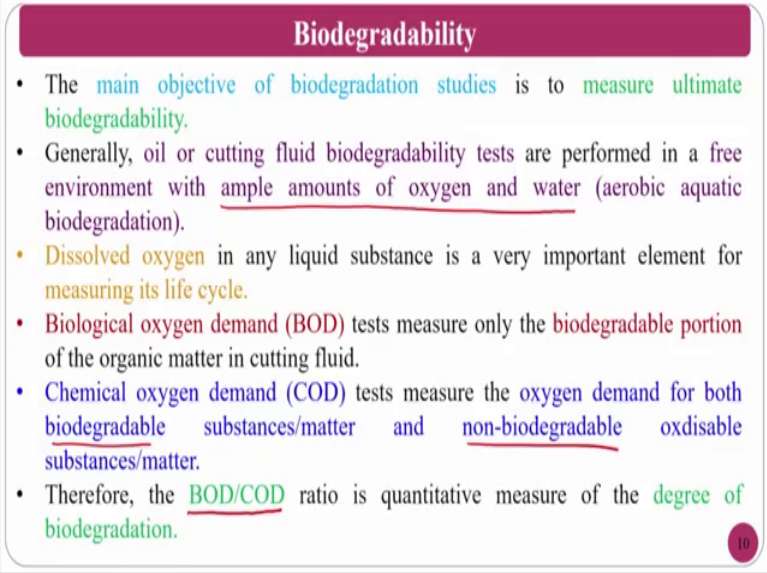

From the main objective of biodegradation is to measure the ultimate biodegradability; that means our main aim is ultimate biodegradability; that means, how much amount of the mineral oil or the commercially mineral oil you can degrade as well as bio cutting fluid you can degrade.

Generally oil or cutting fluid biodegradable test were performed in a free environment where the ample amounts of water and oxygen is there. So, dissolved oxygen is in any liquid substance is very important element for measuring the life cycle, because as the time increases what will happen dissolved oxygen will go down. Because the microorganisms will take it biological oxygen demand test measure only the biodegradable portion on chemical oxygen demands measures, biodegradable substances as well as non-biodegradable substances.

Therefore, BOD by COD the ratio is quantitative measure of degree of biodegradation; that means, biodegradation BOD gives biodegradable part, COD gives biodegradable part plus non-biodegradable part; that means, that biodegradable part divided by biodegradable part plus non-biodegradable part. These particular things gives is degree of biodegradability of that particular material, if it is a commercially mineral oil or the other thing.

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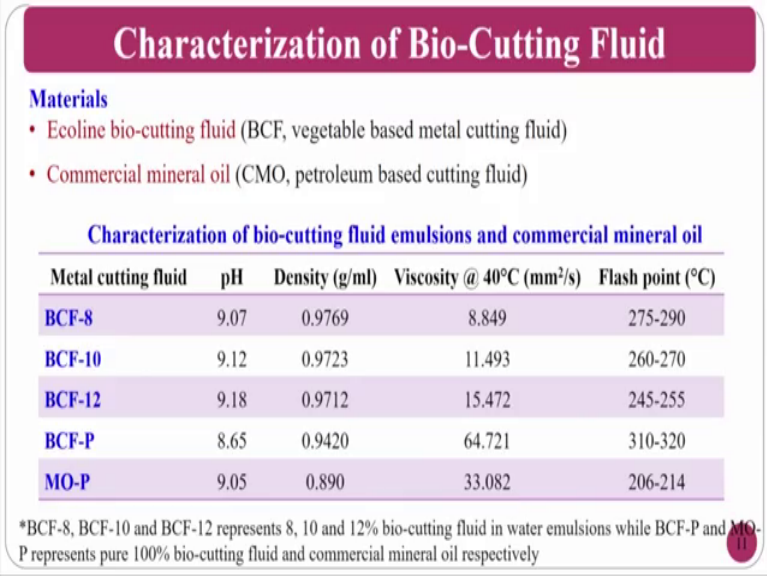

So, if you see the materials normally in our case I have already told we have used the equivalent bio cutting fluid and the second one is commercially a commercial mineral oil. These are the 2 things we have used the test is carried out for these 2, if you see the characterization of bio cutting fluid emulsions and the commercial mineral oil.

Normally since you have seen already BCF 8, BCF 10, BCF 12, that is BCF P stands for pure this stands for pure this stands for pure. So, emulsions are taken at the same time pure also is taken.

You may get the doubt why you are going for this F 10 to 12 this is already shown you in the previous classes, where thermal conductivity as well as specific heat is measured and these 8 to 12 are giving better results.

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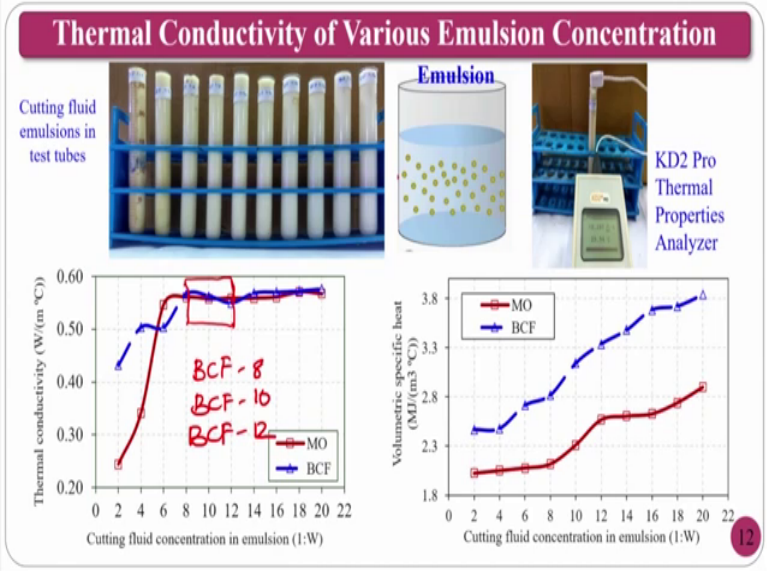

Any, how I can show you and I will come back you to the previous slide, if you see the emulsions the emulsions are made with 1 is to 2 1 to 1 is to 20 that you can see and KD 2 2 probe is measure you used to measure the thermal conductivity of the cutting fluid, as well as specific heat of the cutting fluid.

From these 2 graphs what we got is 10 to 12, if you see after 8 it is giving approximately better results that is why this range is considered in that one that is called BCF 8, BCF 10, BCF 12 that is why from this it is considered in the previous slide.

Let me come back to the slide. So, if now you got it how BCF 8 and 10 8 to 12 are coming. So, p H value p H value is approximately BCF is having very less it is near to the normal that is 7. So, density viscosity at 40 degrees flashpoint these are the some of the details that are given and if you see the mineral oil it is about 9.05 p H, the BCF 10 and 12 since the water content is increasing the p H level slightly is increased here, the viscosity of the fluid the normally if the viscosity of the emulsions is very good. If you see here compared to the pure amount of bio cutting fluid as well as mineral oil so; that means, your emulsions have better flowability and capillary action will be good.

So, at the same time flashpoint also if you see the bio cutting fluid has a very good value and this followed by the 8 10 and 12 and the flashpoint for the mineral oil is too low; that means, from the point of 5 accident point of view also bio cutting fluid gives you better

results. So, this is what you have seen in the previous one where you want to move why you want to move to BCF 8 to 12.

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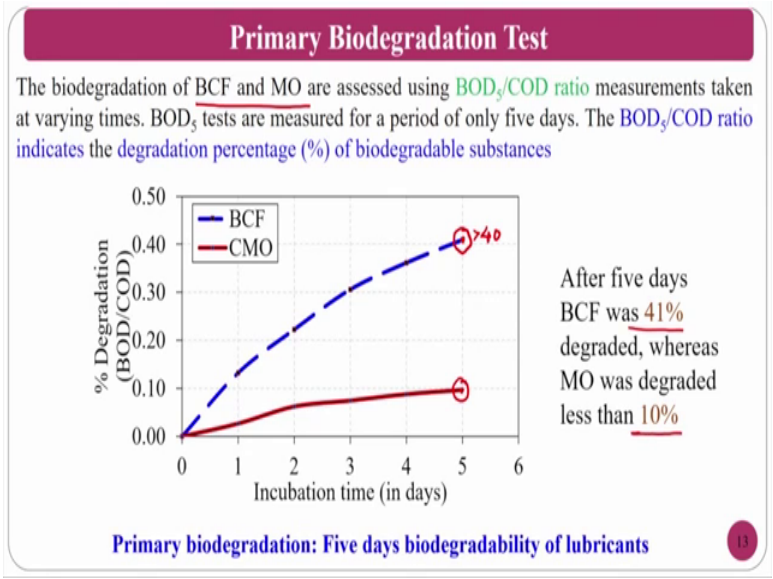

So, primary biodegradation test primary biodegradation test is done for the BCF and MO it is plot for BOD 5 bar COD ratio that is for 5 days the BOD and COD is calculated and the test is plotted between percentage degradation that is we what you have seen BOD by COD gives the percentage degradation. And with respect to incubation time the incubation time as I said incubation time is done for 5 days. If you see here percentage degradation of BCF is approximately 40 above 40 percent and our percentage degradation of this commercially mineral oil is the maximum at the 50 year is about 10 percent.

But if you see here it is about more than 40 percent, like it may be 41 or something. So, after 5 days if you see BCF was 41 percent, but MO was 10 percent. So, from this what one can infer we will see in the upcoming slide?

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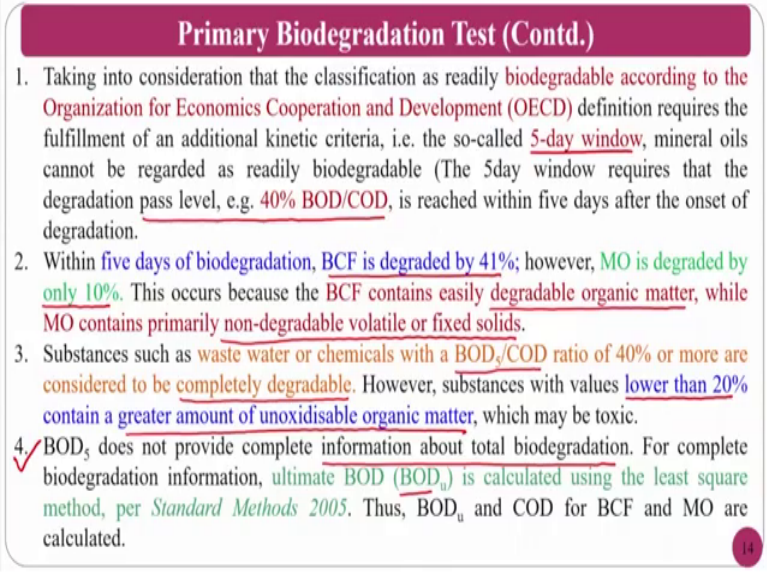

Taking into the consideration what is the inference from the graph is if the 5 days window the mineral oils cannot be degraded as readily as biodegradable 5 days window requires, degradation pass level is 40 percent.

If the biodegradation that is BOD by COD if it is 40 percent or above, you can qualitatively say that this particular material is biodegradable. If it is less than that 1 it cannot be degradable within 5 days BCF is 41 percent. And, however, it mineral oil is 10 percent this, because BCF contains degradable organic matter, but the MO is dominating by non-biodegradable volatile or fixed solids. Because of this one the biodegradability of bio cutting fluid is higher compared to the mineral oil, mineral oils are dominated by the non-biodegradable parts.

If the BOD by COD ratio that is BOD 5 by COD ratio is 40 or more it is you can qualitatively say that it is completely biodegradable completely means you can go up to 95 96 percent and all those things. However, if the value is lower than 20 percent; that means, that greater amount or unoxidisable organic matter; that means, that you cannot degrade these things that. In the previous graph the inference at the bottom line you can draw ease that, if it is more than 40 percent or equivalent to 40 percent that you can degrade completely or mostly you can degrade, if it is less than 20 percent; that means, that it will be dominated by non oxidizable or non-degradable part means, our mineral oil

which is supplied by many of the petroleum companies is non-biodegradable, but if you can purchase the biodegradable thing that will be good from the point of disposing.

The another point which you have to consider is BOD 5, that is the 5 days preliminary experimentation that one did cannot provide complete information about the total bio degradation, but it can give you a preliminary idea saying that you can degrade mostly or if not degrade from the percentage like 40, above 40 percent or below 20 percent.

For the complete bio degradation information ultimate BOD that is called BOD subscript u is calculated using least square method there is a one standard methods are there where you can do extrapolation, but you are not doing any extra experimentation here, you are doing only 5 days experiment, but there are some standard literatures where you can calculate the ultimate biodegradability from the experiment.

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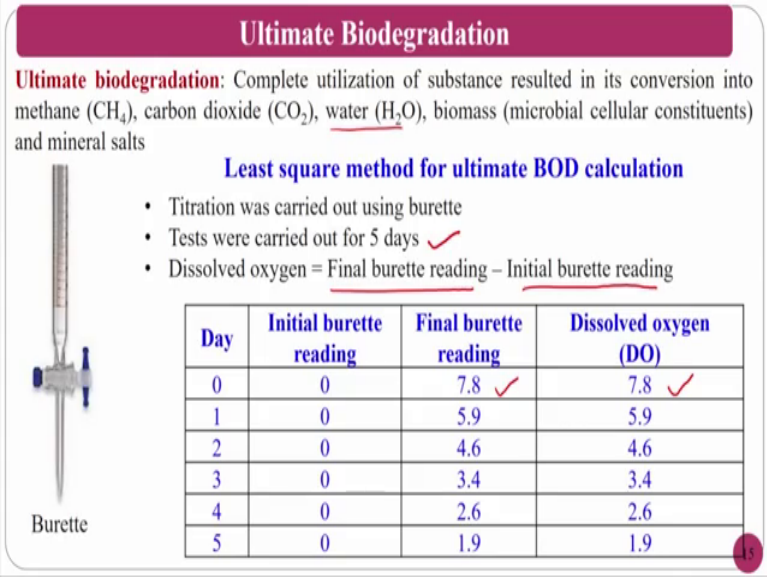

So, now we come across what is now you should know what is ultimate bio degradation? So, ultimate bio degradation means complete utilization of some substance resulted in the conversion into methane carbon dioxide, water and biomass as well as mineral oils, this is called ultimate bio degradation. That means, are complete bio degradation studies how to calculate these tests normally can be done by titration was titration was carried out using a burette normally burette will have 0 reading, then if you fill what will happen it will go to a certain value; tests were carried out for 5 days and dissolved oxygen equal to final burette reading minus initial burette reading.

If you see the table day one initial burette reading always it will be 0. So, final burette reading what I am going to do is I am taking the, you have you come across 2 words which are called effluent and influent. So, effluent means the thing that I am giving if and influent means what I am going to get.

So, once the biodegradation you are checking 1 day 2 day 3 day 4 day 5 day what I am going to do is I am just putting a burette just you have a flask just you do the titration. In the first day you get the reading of 7.8; that means, that it will have a 7.8; that means, second day what is the problem second day if I am taking certain liquid from the system, where my microorganisms already taken the dissolved oxygen. Whenever the oxygen is not there what will happen wherever the oxygen is taken by the microorganisms the oxygen level in that particular system goes down.

So, what will happen again if you do the titration that is burette is there just you put you shake it properly what will happen at 5.9 dissolved oxygen itself it will give you the pink color. Similarly as number of days increases what will happen microbes take more and more and more dissolved oxygen.

So, if their oxygen level is less what will happen this color what is there in the beaker will goes into pink as early as possible; that means, what I mean to say is dissolved oxygen gradually decreases.

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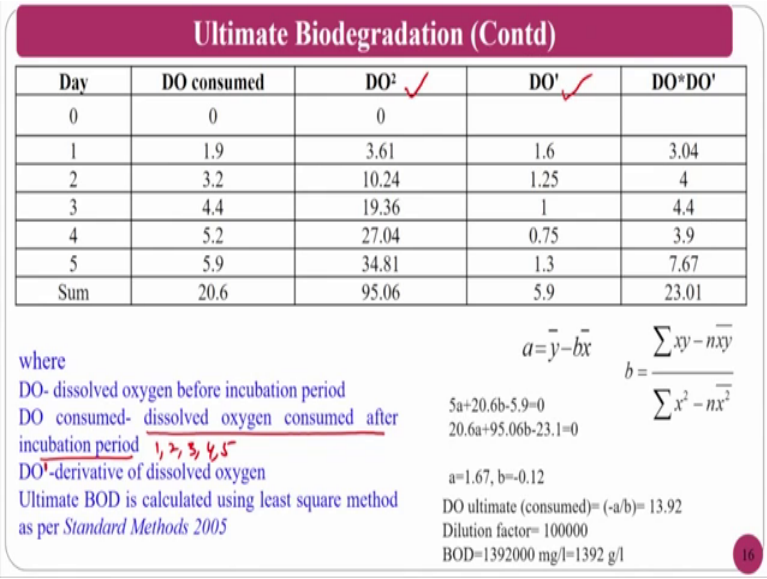

If you see this one dissolved oxygen consumed with respect to time previously what is consumed by the microorganisms. In the previous table it is decreasing trend, because slowly day by day it is consuming here you gradually what we are talking about dissolved oxygen consumed by microorganisms.

So, you can do the square of this one then this is the derivate of there are standard equations and all those things and multiplied by DO and derivative this will give you. So, these are the other things DO is dissolved oxygen before incubation period, DO consumed is nothing, but dissolved oxygen consumed after incubation period a like 1 day, 2 days, 3 days, 4 days, and 5 days DO derivative of dissolved oxygen and ultimate biodegradation calculated by the least square method. This is least square method normally there are some equations and you can come across all these constant and all those things.

This is a standard procedure which is a just a simple mathematics you can go ahead and you can read in the normal text books of environmental science and all those things.

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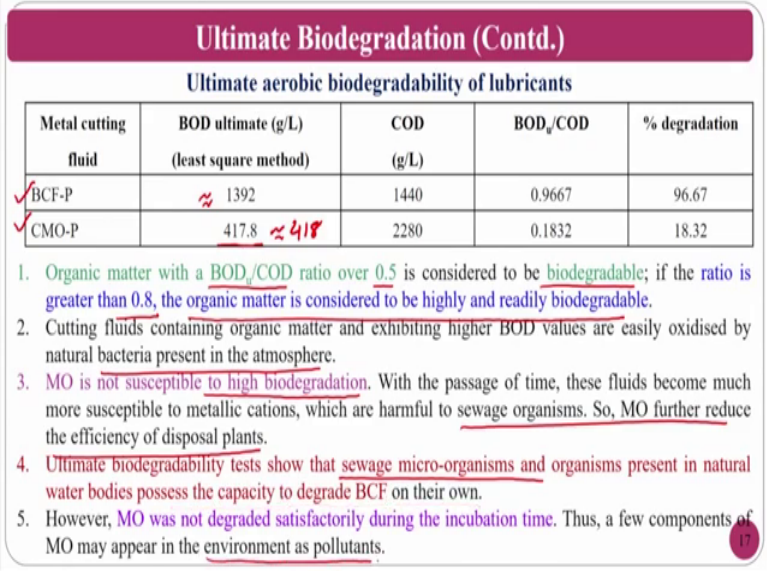

If you calculate all this least square method you come up like BCF-P and co CMO-P; that means, pure BCF and pure commercially mineral oil BOD ultimate is 1392 as well as 4179 ok. That means, you can BOD stands for biodegradability of biodegradable material only.

So, you can degrade this much; that means, approximately it 900 in the CO commercial mineral oil you can degrade only 417.8; that means, that approximately 400 and 18 percent you can degrade, but if you see in terms of bio cutting fluid you can norm it is approximately like 1392 you can degrade 1392; that means, that approximately 900 plus you can DO.

So, what I mean to say is here the biodegradable content of the BCF is much higher compared to the commercial mineral oil, COD also if you see COD. So, COD here very less is present, but here COD is higher since already most of the thing is done in the BOD.

So, BOD by COD which gives raised to approximately 96.67 percent is the ratio that is bio degrade percentage biodegradability is 96 percent or 97 percent approximately whereas, if you see the ultimate biodegradation of a the commercial mineral oil is 18.32 percent that is approximately or maximum it is less than 20 percent ok.

Organic matter with BOD ultimate by COD ratio over 0.5 is considered to be the biodegradable; that means, that if the particular value is above 0.5, then it is considered to be the biodegradable material, but in our case biodegradable or the bio cutting fluid is 0.97 that is means it is too good for biodegradability.

If the ratio is greater than 0.8 the organic matter is considered to be the highly or readily available; that means, if it is 0.5 it can be degradable or biodegradable. If it is above 0.8 which is in our case of bio cutting fluid; that means, that I am ready you microbes come and degrade me like that it is there.

So, biodegradability is so, high that it is readily available elements are there in the bio cutting fluid. The cutting fluid contains organic matter exhibiting higher BOD values are easily oxidized by the natural bacteria present in atmosphere; that means, that if your BOD value is very high; that means, that bacteria can be easily degrades it 1 mineral oil is not susceptible to high biodegradation, because if you see it is 18 percent or approximately, 19 percent you can say maximum it is having the biodegradability.

That is why the remaining things E goes as a pollutants, if only 18.232 percent 18.32 percent is biodegradable the remaining amount is as a waste or it goes as a pollutant; that

means, that the pollution caused by the commercial mineral oil is so, high compared to BCF.

So, ultimate biodegradation show test the sewage microorganisms and organisms present in natural bodies possess the capacity to degrade BCF on their own; that means that there is no requirement of additional things. So, whatever the microorganisms that are there in the sewage system or in the water bodies that itself is sufficient, it can degrade, there is no additional things you require if you are disposing of the bio cutting fluid ok.

However the mineral oil is not degrade satisfactory during the incubation period thus the components may appear in the environmental pollutants, that is what I want to say that 18 percent you are degrading remaining is undegradable. So, it will cause lot of water pollution, if you dump these types of commercial mineral oils.

However, if you dump the bio cutting fluid after the utilization also so, there is no requirement the existing microorganisms which are there in the water bodies can degrade.

Now, we come to a new term that is called the hydraulic retention time. So, hydrolytic retention time tells about the ultimate time to degrade.

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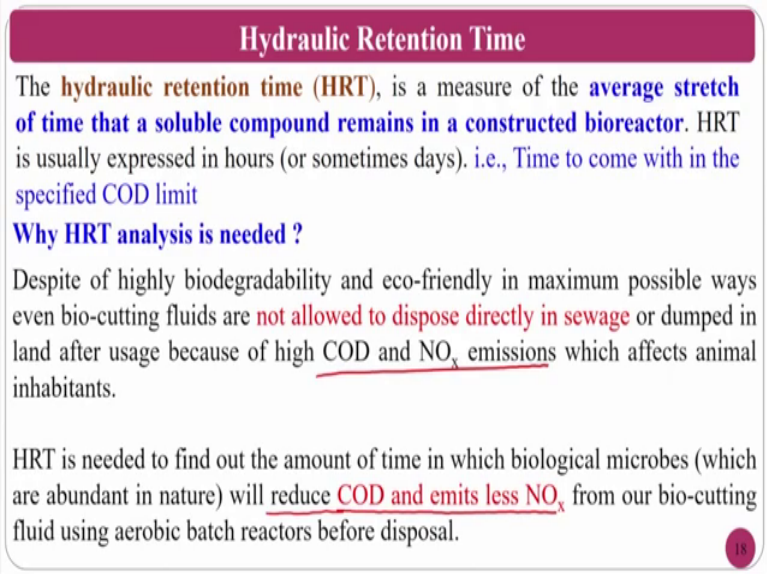

So, hydrolytic retention time is a measure average stretch of the time that is soluble compounds remain in a constructed by a reactor; that means, what I mean to say is from

the see statement you may not get much idea, but let me say something, assume that the government specified that you should have the BOD or something like 200.

So, assume that my cutting fluid has 12 100 ok, I cannot dispose because it has to come to 200 then only I have to dispose, in a bioreactor if I am testing the time required to bring my degradation or the BOD from 12 100 to 200 the time span is nothing, but hydraulic retention time if my time span is less; that means, that the reaction can be done at less; that means, that the it can be done at faster rate.

So, ultimate goal what I am looking at from this HRT is how much HRT will be less for the fluid. So, both the fluids will check what is the HRT? Why the HRT analysis is required, despite having high biodegradability ecofriendly and maximum possible ways of bio cutting fluids are not allow to dispose directly in the sewage, because of high carbon oxygen demand and NOx emissions, which effect the animal. So, these are the problems that are called the high carbon oxygen demand. So, this is the one other one is NOx emissions is another one.

So, what one has to do is HRT needed to find out the amount of time in which biological microbes will reduce COD and emits less NOx from the bio cutting fluid in a aero[bic]-batch batch reactor ok, that mean that our aim is to reduce the COD and then you have to dump and also reduce the NOx quick and then just you dump it. So, that is what HRT deals about.

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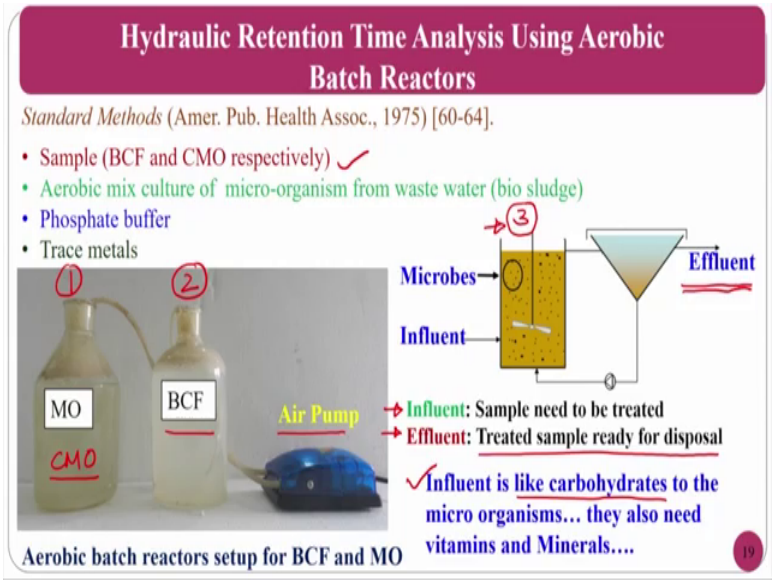

So, simply the experiment if you see here you take the 2 samples that is BCF and commercially mineral oil you just aerobic mix culture of the microorganisms from waste water, phosphate buffer, trace metals, all things you need. If you see this picture there is a mineral oil is there as well as a bio cutting fluid is there commercial mineral oil you can say and BCF is there a pump is there to pump the oxygen, how the schematically if you see these 2, 1 and 2 are represented by this 3.

Just you put microbes and you put influent; influent is nothing, but the sample and effluent is nothing, but the treated sample are ready for the disposal; that means, what this is the effluent that we have done for the titration. Their burette and all those things are there you know this you are taking here with respect to number of days, you are effluent dissolved oxygen will go down. First day there is no dissolved oxygen because there is no microbes 0 day you will have the complete dissolved oxygen that is why the value is around 7.9 8 or something. As you days increases what will happen these microbes will eat away in the 3 in this one it will eat away some of the dissolved oxygen or it will consume them of the dissolved oxygen. So, dissolved oxygen content gradually decreases in the effluent.

So, what is here we are doing is in the commercial mineral oil as well as BCF you just put the microbes, as well as the water, effluent, influent and all those thing influent is nothing, but BCF in one case another one is mineral oil in another case you just pump to the oxygen, this is a air pump which you can pump the oxygen.

So, if the influent is like a carbohydrates microbes are there in a system microbes are there where if you put influent it can take as a carbohydrates, but it cannot continuously take and all those thing because it need proteins any human always you cannot consume the carbohydrates only.

So, you need proteins, you need vitamins, you need many things, for that purpose you have to add these trace metals.

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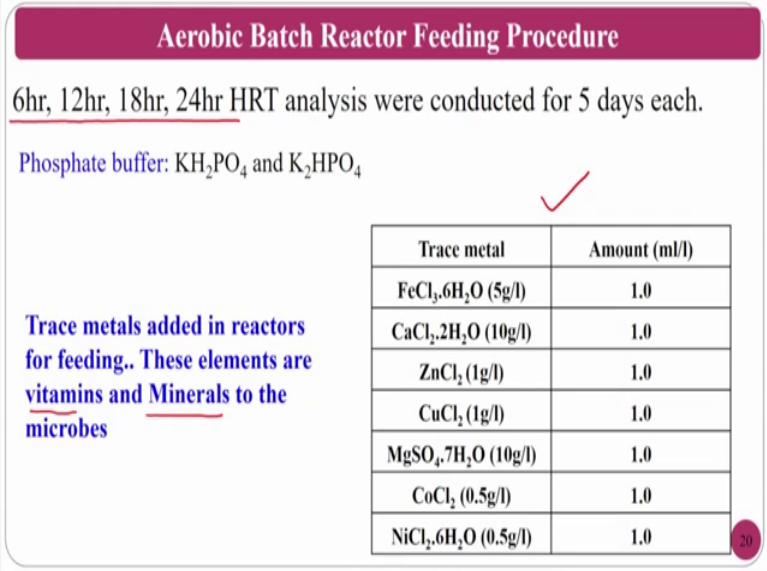

So, you if you add these trace metals these trace metals act as vitamins and minerals. So, that it will consume the amount of carbohydrates that is nothing, but what influent which is you are adding that is BCF or MO and it will consume with respect to hour like this test is done for 6 hours, 12 hours, 18 hours, and 24 hours analysis is conducted for 5 days each phosphate buffer is also used in this case.

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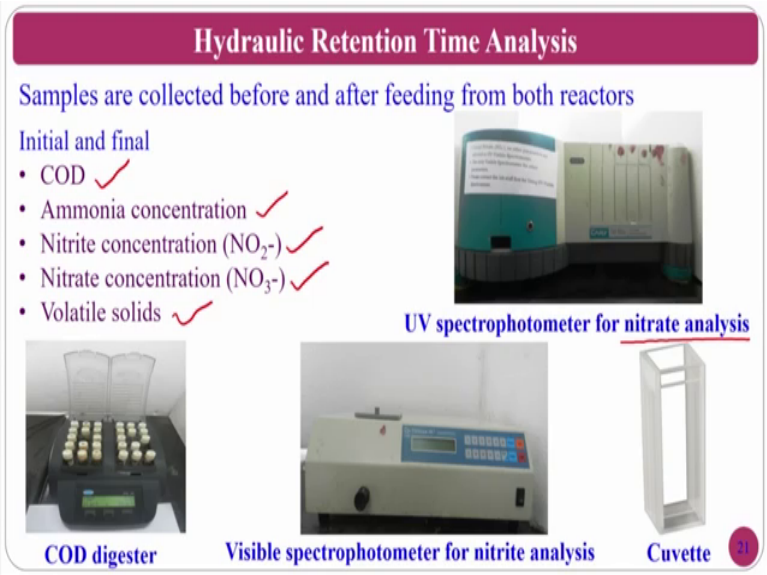

Just you take the samples before and after feeding from the both reactors so; that means, that my a pump is pumping parallelly to the both one ok. If you see that picture the air pump which pumps the oxygen to MO as well as the BCF parallelly.

So, if you take the thing after before and after you can measure the COD you can measure the ammonium concentration, nitrite concentration, nitrate concentration as well as voltage solutes these are all you can measure. So, COD digester is there just you have to take the effluent that is coming out start one after 1 day, 2 day, 3 day, or after hours we will just to take few ml and you just to put in the COD digester and you can get the COD value.

At the same time if I want nitrite and nitrate concentrations just you place in the UV spectrophotometer as well as visible spectrophotometer for the nitrate analysis for UV spectrum photometer for the nitrite analysis, you can use the cuvette and you can put in the UV as well as visible spectrophotometers and you can get the values of nitrites and nitrates.

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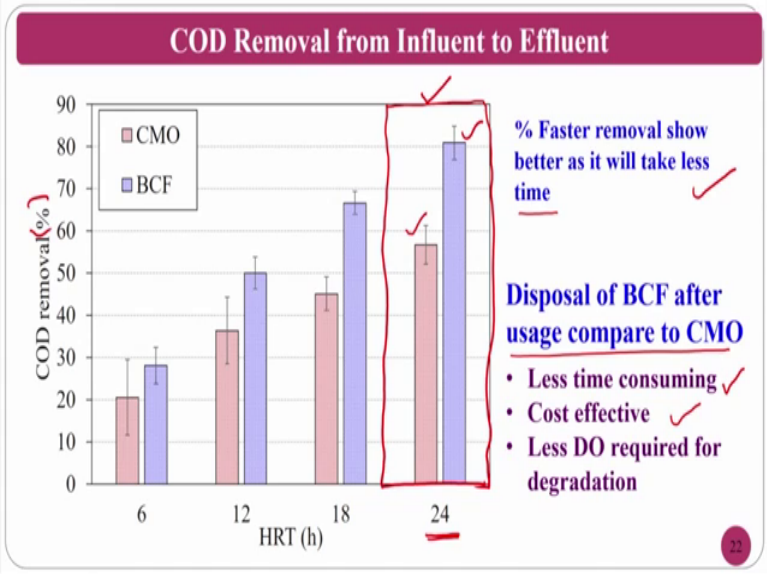

One thing I want to say here is you will get ammonium in the form of ammonium. Ammonium can be in nitrites as well as nitrates not only nitrites and nitrates, it is the ammonium will also contain a some other material ok.

It does not mean that if the ammonium percent is very high nitrites and nitrates, which are dangerous to the organisms, are high. So, that slight also you will come across there I will tell you the COD removal if you see with respect to time, what is here if you see the COD removal percentage. If you see the COD removal percentage always your bio cutting fluid is higher; that means, that with respect to this particular time of 24 hours, how much you can remove is with the same time if you take any particular curve assume that I am going to take this particle portion, that is 24 hours because everywhere BCF is having higher value.

So, let me consider this way this particular bar graph part. What I mean to say if this is there. So, the commercial bio cutting fluid will have this value at the same time commercial mineral oil have this value; that means, how much carbon oxygen demand removed is showing here? That means, that if the removal thing is very high; that means, that it can be done at faster removal; that means, what I have here shown that percentage faster removal shows the better and it will take less time; that means, that if within the 24 hours, if you can remove around 80 percent is in BCF, but at the same time you can remove only 56 percent or 57 percent in this one.

So, the time same, but the removal rate in BCF is high for the same time commercial mineral oil removal rate is very less; that means, that if you are going to dump this both fluids into the river body or the nearby water bodies what will happen the commercial mineral oil will take larger time or more time to degrade, but BCF take very less time if it is very less time; that means, that it is oxygen demand also less. So, the organisms freely or easily can degrade it.

So, disposable of BCF after uses compared to CMF it is less time consuming as I said because the percentage degradation is very high compared to commercial mineral oil cost effective, because if the reactor from the point of reactor I am seeing assume whatever we are doing here is a laboratory scale. If a big company multinational company is there and if they want to dispose it off what they have to do first they have to bring the COD to the limit of the government specifications, then they have to do it?.

For that practical, for that particular application what one has to do you need to do the HRT analysis? What HRT analysis the HRT analysis you do you have a 2 things what is the experimental and you just pump the oxygen, oxygen, oxygen and you do for 24 hours

or something what is so, what is it is a matter of oxygen cylinders, how many cylinders, they want and all those things. At the same time you are if you are degradation time means or bringing the COD taking lot of time in case of mineral oil it is time is money, if you cannot do it in less time your production cost will go up that is what I want to say, less dissolve oxygen is required for bio degradation because from the previous graphs you need very less dissolved oxygen for bio cutting fluid compared this one.

So, degradation is faster in the bio cutting fluid the degradation is slower in case of commercial mineral oil that is what the meaning what I want to convey here. How for the same time percentage degradation of commercially available mineral oil is only 57 percent or something 24 hours, in the same time it is about 80 percent; that means, that there is a variation of 24 or 25 is there.

Degradation time or the time to bring from certain value to the government specified value to dispose is very less, at the same time if you are having million tons and million tons of the fluid what will happen you have to feed the oxygen and some other at the time of your reaction is also very high. This is not cost effective from the point of commercial mineral oil; dissolved oxygen also required less in terms of bio cutting fluid that is what I want to say.

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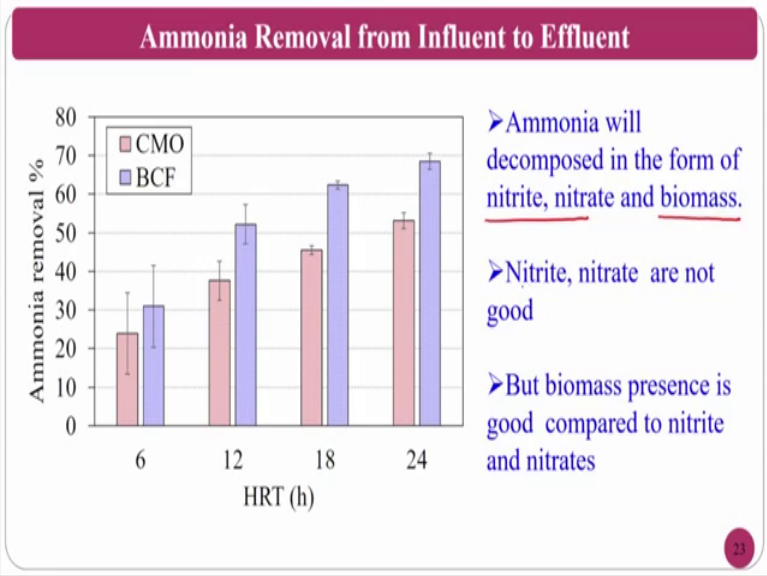

If you see the ammonium removal, the ammonium removal also good in terms of the bio cutting fluid, you may get doubt at this point of time saying that why the ammonia is not

good from the point of nitrites and nitrates, but here your bio cutting fluid is giving higher amount of ammonium removal. So, you just remember that I have said some of the sentences in the previous slides, ammonium contain nitrites and nitrates as well as biomass also.

But nitrites and nitrates are not good for the organisms, but the biomass which is there is very good for the bio organisms compared to nitrites and nitrates; that means, that even though I am emitting or bio cutting fluid or commercial mineral oils if they are emitting the ammonium do not worry, but the thing is that this ammonium contains 3 things one is biomass as well as nitrites and nitrates biomass there is no problem, if the nitrites and nitrates amount is very high in BCF that is danger. So, you should be careful about nitrites and nitrates emission not about the ammonium.

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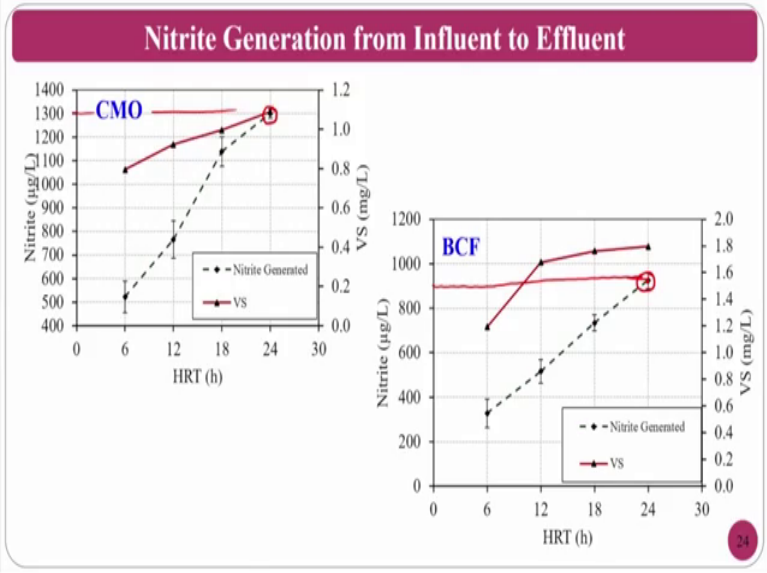

We will move on to the nitrite generation if you see the nitrite generation in the commercial mineral oil it is higher, if you see here the commercial mineral oil the nitrites generation is approximately 13 100 , but if you see in terms of the bio cutting fluid it is around 900 something or something you can say. So, this is approximately 900 or plus or minus 10 you can say here it is approximately 13 100.

So, even though you are emitting higher amount of ammonium from the previous slide do not bother only thing is that, if you see here it is clearly shows that bio cutting fluid

contains less amount of nitrites and more amount of biomass, biomass you can degrade it.

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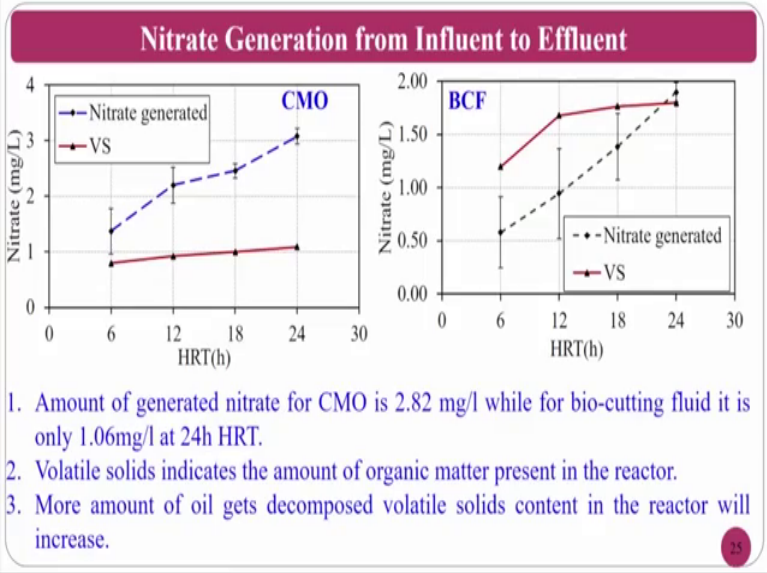

If you see from the nitrate point of view also the nitrate point of view previously it in terms of micrograms, here it is in terms of milligrams please note that it is in the milligrams that is why the value is small; here it is in the micrograms.

So, that is why the value is slightly bigger if you see in these terms also nitrate generation it is approximately more than 3 in the commercial mineral oil, but in case of the bio cutting fluid it is approximately less than 2 milligrams per liter. So, that means, that nitrites as well as nitrates are less even though ammonium is high in terms of BCF; that means, the biomass content is higher in terms of the or the volatile solids content is higher in terms of the bio cutting fluid.

Amount of generated nitrates in CMO is 2.82 while it is 1.06 approximately or less than 50 percent it is their volatile solids in indicate the amount of organic matter present in the reactor; that means, that do not bother about the organic matter, but if; that means, that you can degrade this one the more amount of oil gets decomposed the volatile solid content in the reactor will increase, that is if you are increasing the number of days what will happen the volatile solids is going to increase.

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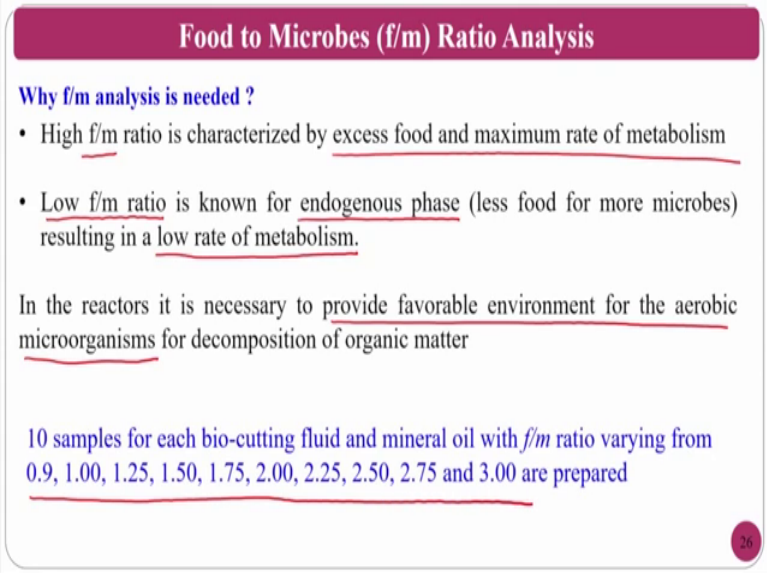

Now, we will move on to food to microbe's ratio. So, food is most important for anybody. So, how you have to feed the microbes in the laboratory scale, but how this analogy will move to the practical system ok. So, practical system goes like this if I have a cutting fluid whether it is a bio cutting fluid or whether it is a mineral oil cutting fluid just I am dumping it for the biodegradability in the nearby water body.

So, water body microorganisms are constant only thing is that it required food ok. Food is a variable. So, that test we will do if I give you more food what will happen it will eat and it will also die, if I do not give food what will happen it will also will die. So, you one has to give appropriate amount of food to the microbes, that we will check high amount of food to microbe ratio is characterized by excess food and maximum rate of metabolism.

And if with the low amount of food to microbe ratio is known as endogenous phase less food for more microbes ok, resulting low rate of metabolism the reactor is necessary to provide the favorable environment for the aerobic microorganisms for the decomposition of organic matter, whatever the thing here it is nearest to values are given here.

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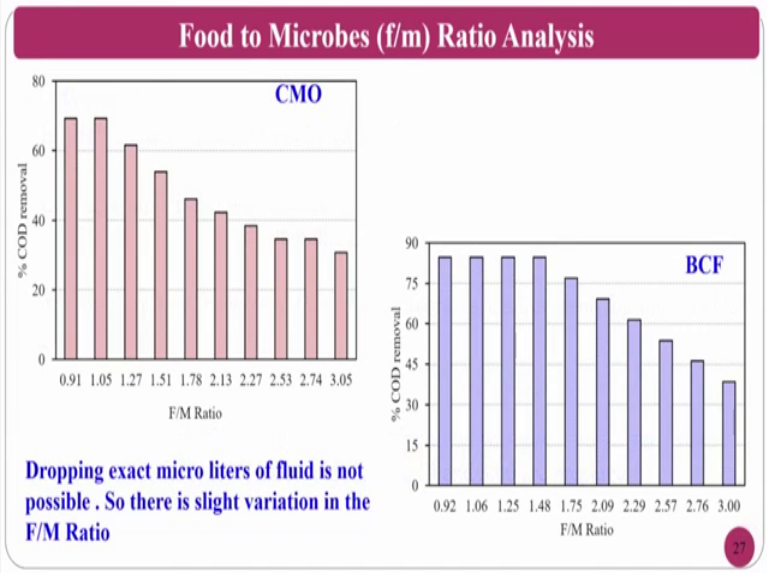

But if you see the graphs it is very difficult for the particular persons who work in the laboratory to give micro to Nano liters of this cutting fluid.

So, for that is reason you may see some of the variation in the slight variation in the food to microbes ratio, if you see the food to microbes ratio as the food to microbes ratio is increasing here what will happen your COD removal is gradually decreasing. What is the phenomenon if the microbes is if you are giving more and more food what is the problem is it is eating eating and they are dying themselves and all those things.

So, the COD removal is gradually decreasing there is a certain value there is a it is a good and later on it is start decreasing, because it is eating overeating overeating may also cause the organisms to die, that is why the COD a percentage req will gradually decrease after some time ok.

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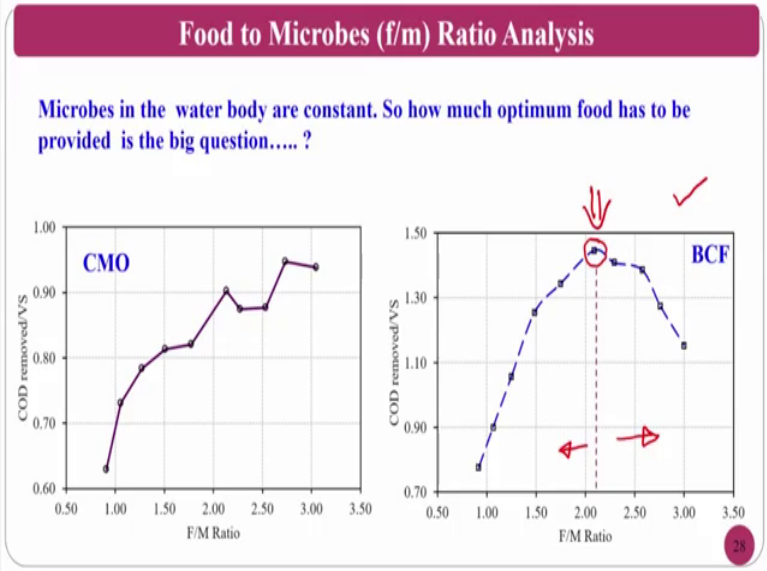

Most importantly microbes in the water bodies are constant. So, how much optimum food one has to give, if you see the picture in the C CM commercially mineral oil as well as the BCF, let me talk about BCF which is a beautiful curve if you see this particular line before this one what is happening is your food is less microbes are more in this region your food is more, but microbes are less. So, optimum point you have to find. So, that the microbes will get a right amount of food so, that the system will degrade.

Now, I will come back to the first slide of food to microbes ratio, what I said there is you need to put the food. From this particular graph what I want to convey is I have a river body assume that I have a Brahmaputra river. I have the microorganisms in it and I want to degrade my cutting fluid in that circumstances, I want to give the food if I give less food the organisms will die without degrading my cutting fluid. If I give more what will happen if it will overeat and it will die so, I because the organisms are constant because I am not controlling the organisms in the river.

So, I have to give that particular thing we will simulate or we will do in the laboratory scale by taking number of organisms, which in the whatever the water body and we try to give the food if and we will simulate it.

So, this is the optimum value where you can give. So, that the better thing can be happen form on the biodegradation point of view from the food.

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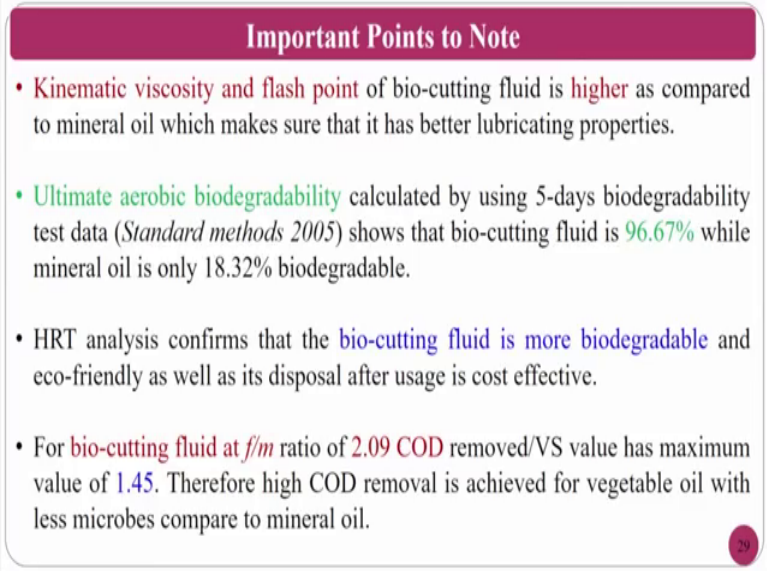

So, kinematic viscosity these are the important points to be noted and summary of the today's lecture is goes like this, we have studied what is biodegradability and what is degradation and all those things.

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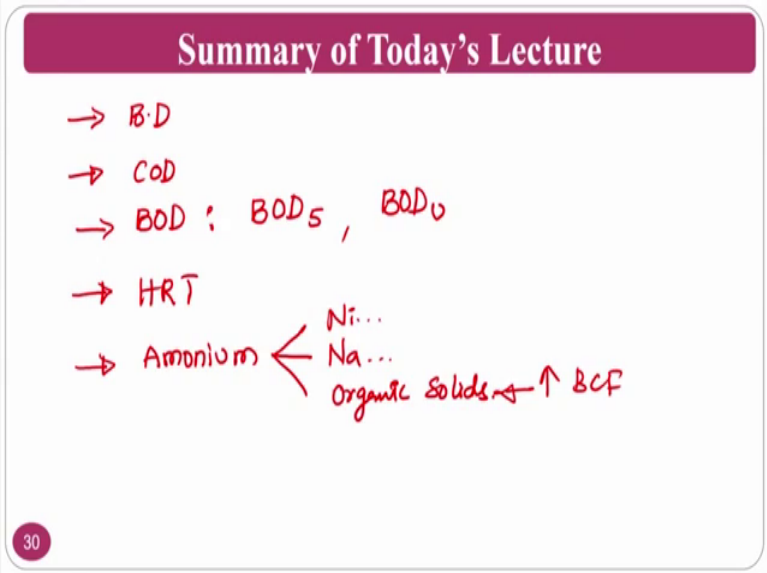

Then we come across COD, we come across the BOD, in BOD also we come across BOD 5 that is for 5 days and BOD ultimate.

So, then we came up with the HRT analysis hydraulic retention time which is normally we want HRT less. So, we have compared then we have checked for ammonium, in the

ammonium we have 3 parts which we have checked for the commercial mineral oils as well as the bio cutting fluids one is the nitrites another one is nitrates I am not writing full name ok. So, another one is the soluble solids basically organic solids ok.

The ammonium in BCF is high, but that particular ammonium has less amount of nitrites as well as nitrates, but in BCF the amount of organic solvents are high in BCF. So, that is why even though the ammonium is high that particular graph do not bother, but it contains major chunk of organic solids, but BS, but if you go to the commercial mineral oil nitrites as well as nitrates are dominating.

So, this is about the today's lecture and most important lecture that I have taken today in from the point of humanitarian grounds. Whenever a person who is operator it is your responsibility as a manufacturing engineer for the well-being of the operator.

So, about the cutting fluid cutting fluid emissions, cutting fluid properties, how to degrade biodegradability, thermal characteristics, rheological characteristics, these are all are covered as a major thing in this particular course till now.

So, we also see some of the things about the cutting fluid in grinding as well as in other lectures also , but as such the cutting fluids has or the machining fluids has it is own importance in the present scenario ok.

So, that is why I named this particular course as a machining as well as machining fluids. In fact, it is a introduction.

So, as the world progresses this will become too preliminary and introduction goes to preliminary preliminary goes beyond, that is why I named it as a introduction to the machining as well as machining fluids.

Thank you for the today's class and we will see you in the upcoming class.