Water Quality Management Practices

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Lecture-08

Determination of BOD, COD & TOC

Hello everyone, welcome all of you to this NPTEL online certification course on Water Quality Management Practices. My name is Gourav, Professor Gourav Dhar Bhowmick. I am from the Department of Agriculture and Food Engineering of Indian Institute of Technology, Kharagpur, India. With the continuation of my discussion on the quality estimation of major pollutants, today I will be discussing about how to determine the biochemical oxygen demand, chemical oxygen demand and the total organic carbon. So, in this particular lecture video, I will be covering the concepts like the procedures, the conditions and the factors involved in conducting biochemical oxygen demand test. The test and purpose of determining the chemical oxygen demand in wastewater, the potential sources of interference in the COD test and the determination of total organic carbon in water.

To start with you know the biochemical oxygen demand is what it is it is nothing, but it is a kind of a quantification of the biodegradable organic matter present in your system say whatever the sample you have say like water or the wastewater sample. So, most of the cases this biodegradable once can be easily quantified using this BOD test and we sometimes have to go for a COD test in order to understand the presence of biodegradable as well as hardly biodegradable organic matter present in your sample whether it be water or wastewater solutions. So, this is the basic difference between the COD and the BOD I would say. So, in the BOD from the name itself you can understand it is a biochemical oxygen demand means some biochemical reaction is taking place.

What we are doing we are simply in order to make it much more simpler I would say what we are doing we have a certain small container in that container we have our sample solution. In that sample solution we purposefully introduce some inoculum some amount

of active microorganisms. So, those will consume in the presence of oxygen and it will degrade the the the obviously, the the the the the organic matter present there and by means of by means of this the changes in the dissolved oxygen level we can easily quantify the biochemical oxygen demand. I will show you how to quantify it what is the procedure of it, but this is the basic understanding this is the basic ah ideology behind this biochemical oxygen ah biochemical ah oxygen demand test. So, majorly it indicates the organic pollution high BOD level indicates the presence of organic pollutants and even the low BOD level also indicate the organic pollutants.

However, if your like you know regulatory bodies are ok with say like 30 ppm or 30 milligram per liter or say 50 ppm or 50 milligram per liter of BOD then it is perfect, but in most of the cases ah more than 50 milligram per liter in regardless of the ah you know the regulatory bodies most of the cases it is considered as highly polluted I mean like the polluted the water is considered as polluted if the BOD level is more than 50 milligram per liter in general. It also used ah for monitoring the environmental health we can easily detect the pollution event all of a sudden suppose any ah certain ah cultural event is happening and also like you know any slaughterhouse waste is going to ah in to the surface water bodies and all any in any or any other cases where people lot of people will be involved at the same time and where or some ah slaughtering or say like you know some animal ah bodies involved or some ah kind of ah processing industries are involved in those cases there is a chance of certain peak in BODs right. So, this sudden peak in BOD the organic matter the the presence of organic matter the more the organic matter in the water water body the BOD level will high right specially the biodegradable ones. So, this is what actually it is gives us an indication that the water body is getting polluted with the because of the presence of those organic matter and it ah this BOD BOD value once we know the BOD value it can actually gives us an indication that the pollution events are occurring somehow and you have to somehow restrict it. It also helps authorities to enforce the water quality standards as I was mentioning that different regulatory bodies has different standards that they normally mention they normally ah give the notification notice to the all the concerned authorities and industries and the municipalities that you have to maintain this much of BOD only you cannot your end end ah like you know waste water I would say like you know the effluent or say like you know your discharge water has to be has to have the BOD level of less than this then only you are allowed to ah throw it or allowed to discharge it into the surface water bodies you understand.

So, this is the this is how the BOD is important for ah like you know for any regulatory bodies to understand the level of contamination or the level of pollution the water is causing into the ah the or the or the industry or the municipality is causing ah to the surface water bodies. It also gives us an indication of the impact on the aquatic ecosystems because high BOD means it will definitely deplete the dissolved oxygen present in the water and it

can be highly essential for survival of aquatic life and so, it can also cause what the eutrophication phenomena can also occur start occurring ok. There is a certain correlations between them as well. So, in general high BOD is obviously, is not acceptable and you we are trying to ah like you know reduce the BOD level to a considerable amount. So, that it will be ok for ah discharging to the ah surface water bodies.

So, that aquatic ah my ecosystems can easily thrive to that. What are the basic purpose of BOD test? As I was mentioning the accessing the water quality monitoring the pollution and evaluate the treatment efficiency that is also very important. If you want to understand that your ah plant or say like whatever the reactor that you have designed if it is working or not you need to understand the BOD value. Suppose you have a water treatment unit or wastewater treatment unit. So, it is initial wastewater that is come into contact with this ah tank or the just ah in the goes inside this tank it has say like the which we call influent.

Suppose the influent has a BOD of 100 milligram per liter and after a certain detention time when the water will pass through this tank suppose it has a BOD of say 50 milligram per liter. What does it mean? It means that particular unit has an efficiency of 50 percent BOD removal. Now you design another systems which can treat the water further and the effluent has a BOD of 25 milligram per liter. So, that means, the new design is much more efficient is not it. So, it can because it can remove 75 percent of the ah BOD is not it.

So, initial 100 now it is 25. So, 70 percent 75 percent BOD removal can be ah achieved. So, that means, the second system is more efficient than the first one. So, that is how we can easily evaluate the treatment efficiency of a newly designed systems or the existing systems with a temporal or the temporal basis. What are the procedures and the conditions in conducting the BOD test? First the test conditions for ideal BOD test we need to have provide them with a nutrient because you know what we are doing as I was mentioning at the very beginning that in the bottle we are simply putting some active microorganisms and sometimes we may not have to put as well like it depending upon a type of wastewater.

Sometimes the sanitary waste it also has it it automatically has some ah microorganisms in it which will actually work on it and we do not have to additionally seed it we have to supply with the additional seed or we call it seeding actually this artificial ah like you know this inoculation is called the seeding event ok. So, for ideal BOD test nutrient should be available for those microorganisms to survive other than organic matter. Near neutral pH the pH should be ah maintained. We if it is possible you add some buffer so that you do some pH adjustment before the BOD test. Absence of microbial growth inhibitor there should not be a lot of ah heavy metals or any reactive oxygen species or any other consequences or any ah circumstances work at which the the life or the those ah microorganisms which are their active microorganisms their life will be threatened ok.

And also the stable temperature if the temperature will change definitely the type of microorganisms will which is thriving in that particular solution will also change and it will also it will actually hamper and give you the erroneous result. The sample seeding ah need for a mixed group of microorganisms in the sample sample which we call the artificial seedling seeding. In case of ah sanitary sewage we do not have to go for artificial seeding because it is like un un seeded BOD test is also enough because those ah sanitary sewage already has some kind of some kind of micro some amount of microorganisms which can act as an inoculum in this case. The test duration ah in general 5 days of incubation is ah provided at 20 degree Celsius it is like the standard ah technique. So, 20 degree Celsius at 5 day is standard.

However in Indian conditions sometimes we go for 27 degree Celsius for 3 days ok. I will discuss about it why we choose this particular 5 day or 3 days of ah duration which is quite long is not it because, but just imagine the organic matter that is that you are supplying that the your sample has. So, it will take some time for your microorganism to consume it. So, we take into consider this duration like at we like you know for this duration like suppose we have to, but this this consumption this process can can go on for 20 days 30 days and go and like infinite time theoretically. However we have to have a standard you know protocol the based on that actually this 5 days of 20 degree Celsius ah things are coming up and actually there is a funny story also about it.

So, it says that you know in the early days in the I mean like in the if you see the in England if you go to the Thames river. So, from Thames river ah if you go like from any point of time when the water is actually from its source when it actually ah generates like you know in natural sources it it will not take more than 5 days to reach to the ocean. So, there are some ah prophecy like you know say like you know this is how actually ah like you know we come into come with this number at 5 days of this number ok. So, anyway so, in general ah ah 5 days of incubation period is actually maintained ah and approximately 70 percent of the oxygen demand is to be satisfied during this period that is what we normally do if it is satisfying that means, our test procedure the test duration is quite ok. The seed correction sometimes the oxygen demand attributed to the seed then the additional inoculum when you are adding those inoculums are also actually contributing to some kind of organic matter they are they are biomass body mass is nothing, but organic matter ok.

When they will die that will also consider some add some additional organic matter to the system is not it. So, in order to ah correct this ah the the oxygen demand which is attributed because of the seed ah additional artificial seeding we have to substrate that value with the overall BOD measurement ok that this called the BOD corrected which is equal to BOD

measured minus the oxygen demand of the seed or the blank we call it ok. So, what we do ah in case of pH adjustment we normally add some buffers and also the our pH is ah neutralized ah which is preferred for the biological activity to take place and what are the different interferences that can happen in the BOD test definitely the lack of nutrient. If you do not add those nutrient what will happen? It is more like you know you cannot only sustain by the carbohydrate you need to have a protein, fat, minerals, ah other ah water etcetera etcetera. But so, in order for your aerobic microorganisms or whatever I mean like or the microorganisms that you are that you are providing to your system through sustain they need then only need they not only need the organic matter, but they also need some other heavy metals or some other nutrients as well.

So, you need to provide those nutrients ah to the systems as well. However, the presence of additional heavy metals can also cause another problem. Some amount of metal mineral concentration is ok some amount of mineral is ok, but heavy metal like huge amount of presence of heavy metal can also cause drastic changes in the system and all. Majorly this metals will start accumulating on the glass chamber and all and also create a different kind of different kind of habitate for the microorganisms which can actually cause harm to the systems. And also it can oxidize and it can also utilize some amount of additional oxygen and your actual result will be erroneous.

And also the residual chlorine that is also another major problem that can be easily eliminated actually there are procedures I will be discussing very soon. What are the processes and factors in the conducting BOD test? First the oxygen estimation. So, at the very first what you do you take the sample you have a like 300 ml beaker in the 300 ml beaker you take the initial reading initial dissolved oxygen value. So, before even taking the reading like you know that distilled water that you put in the 300 ml beaker I mean like in a container that water has to be aerated for the overnight. So, you have a aeration you provide aeration to water aeration means nothing, but artificially you are providing the oxygen it is like dissolved oxygen just like you do it in the aquarium you have this diffuse aerator you remember you know.

So, diffuse aerator like that you put it in a small bucket you have the distilled water there you keep the aeration device on. So, with time what will happen the dissolved oxygen level will reach to almost the saturation level which is what at 20 degree Celsius 9.07 milligram per liter you know. So, we try to reach to that level at the max as possible. So, next morning you come you put that sample you put that distilled water at a certain ratio along with the sample ah and a fill it up at 300 ml bottle and then what to do you add the ah this ah the the seed or say like you know unioculum, then you also add 2 ml of this manganese sulphate sodium hydroxide potassium iodide Na Na Na Na3 etcetera.

And then you incubate it typically for 20 degree Celsius for 5 days in a incubation chamber ok. So, what will happen with time those seed those bacteria those microorganisms it will keep on consuming the organic matter present in your waste water ok. And along while consuming those it will also need some oxygen because its aerobic decomposition will take place is not it. So, the changes will changes in the dissolved oxygen will occur. So, after 5 day what you will do you will take the sample and either you do the put the DO probe the DO meter and with the DO meter also you can directly ah now a days you can do the calculations that what is the final DO or you can directly do the you can determine the oxygen demand using the FANH 4 2 SO 4 2 which this what and using the ferro indicator and with this you can once you know the final DO and once you know the initial DO you can easily find out the biochemical oxygen demand which is with using this following equations in the in milligram per liter.

Initial DO minus final DO minus 1 minus p, p is nothing, but it is the the volume of the sample divided with the total volume of BOD bottle or the 300 ml that is the ratio of like you know that you are mentioning the amount of waste water that you have divided by the total volume of the BOD bottle in general its 300 ml.

$$\text{BOD}, \frac{mg}{L} = \frac{(DO_i - DO_f) - (1-p)(B_i - B_f)}{p}$$

So, now you multiplied with the blank initial ah BOD initial dissolved oxygen or the DO of the blank and the final DO of the blank. Blank means its only waste water and then you add I mean like in the waste water you just simply add the inoculum ok. I mean like in the in a sorry its a distilled water where you add the inoculum. In case of ah actual scenario what we are doing we are adding sample plus ah this distilled water plus the inoculum, but in case of blank it is only the distilled water and there only you ah 300 ml of distilled water you add the inoculum ok.

So, only because of the inoculum what is the dissolved oxygen depletion that can easily be identified ok and that can be easily eliminated also using this equation. So, this is how we will get the actual BOD value within in 5 days we call it BOD 5 ok. So, let us go ahead with this numerical I would request all of you know if you are having any pen or paper in front of you just open it and try to understand the form ah this example. While performing the BOD test a blank BOD bottle containing only seeded dilution water has its DO level dropped by 1.2 milligram per liter during a 5 day incubation.

So, what does that mean that this is the second scenario this is the blank scenario where there is only dilution water or distilled water where you only add the seeded ah sample this is that means, and in your have a you add the inoculation you add the ah inoculum there and after 5 day the DO is dropped by 1.2 milligram per liter only which is because of the

activity of the microorganisms which acts on its own biomass I mean like in the biomass represented by ah by I mean like the inoculum the BOD we I mean like which is actually ah ah we introduced because of this inoculum ah presence in the present in the system. And also sample BOD bottle was filled with 6 milliliter of wastewater and the rest seeded dilution water what does that what does that mean 6 milliliter and total total volume should be 300 ml as I was discussing. So, 6 milliliter divided by 300 ml that is the selected dilution fraction or the p. So, we can easily find out the dilution fraction here because we know that 6 ml of wastewater is added in total 300 ml of bottle BOD bottle.

So, what is the amount of ah dilution water 300 minus 6 total 294 milliliter of dilution water plus 6 ml of wastewater or the sample total 300 ml ok. So, 6 ml by 300 ml we will get the dilution factor fraction as 0.02 and what else is given its also given that in case of sample bottle the DOD DO drop is around 5.8 milligram per liter during the same time period what would be the BOD 5 of the wastewater.

So, BOD 5 will be the 5.8 the DO drop in the actual scenario in the sample wastewater scenario sample bottle minus 1.2 which ah which is the difference in the the DO drop DO level drop in case of what in case of the ah the blank then we have 1 minus 0.02, 0.02 is the value of p as you remember from this equation the value of p and you divided by now you have to divided with the p that is it.

So, DOI minus DOF is given 5.8 and BI minus BF is also given 1.2 in this equation is not it. So, it is makes it much easier then 1.2 1 minus 0.2 divided by 0.02 you will get the value of BOD 5 as a 231 milligram per liter that is the answer. So, you can easily find out what is the BOD of your wastewater you understand. Next problem in the next problem it is told that for a wastewater sample is expected to have a BOD 5 value of around 300 milligram per liter. So, the BOD is expected to be around 300 milligram per liter and the initial DO ah of prepared dilution water is 7.8 milligram per liter you can see it is almost near to what almost near to the saturation ah ah saturation ah concentration of dissolved oxygen in the water.

Now you are asked to determine the dilution requirement for performing the BOD test. So, initially when you are expecting that your wastewater may be having a BOD of around 300 milligram per liter. So, what should be the dilution fraction? What is this dilution fraction? If you remember that total bottle volume is 300. So, what is the amount of solution that should be what is the amount of wastewater that is should be added and the rest should be filled up with the distilled water or the dilution water ok. So, this fraction has to be ah your your requested or your asked to find out what will be the this fraction, what will be the amount of this dilution requirement for performing this BOD test.

So, BOD approximately 300 milligram per liter and the DO initial is also known to us 7.8 milligram per liter to ensure that a minimum DO of about ah say 1.5 milligram per liter will remain in the BOD bottle after 5 days of incubation. So, the amount of DO available will be somehow 7.

8 minus 1.5 equal to 6.3 milligram per liter. So, even after 5 days say almost 1.5 ah the final DO will be 1.5 milligram per liter. So, what will be the DO difference around 6.3 milligram per liter. Hence the dilution will be required 300 milligram per liter which is like the total ah I mean like the expected ah BOD divided by the ah the the DO change in DO. So, from there you can easily get the P value isn't it. So, it is 46 point ah 47.62. So, let us take a dilution of around 50 to 60 times.

What does that mean? It means like 50 times that means, 50 times dilution is means what like 300 instead of I mean like ah once you have a you have a 300 ml of bottle you have to add 6 ml of wastewater in total 300 ml of ah bottle. So, 6 ml divided by 300 how it will what it will become 1 by 50. So, from there you can get the that means, 50 times dilution is needed that means, you have to have a 6 ml of wastewater and then 294 ml of dilution water or the distilled water which is already aerated from before that is how we calculate the BOD ok. I hope you understand the procedure you know.

So, next is the chemical oxygen demand. We will be discussing more about this BOD in the coming lecture and we will design we will do the modeling of BOD and we will try to understand more in details and its correlation with COD and TOC, but before that I want you to understand the concept first. So, this is the next one next very important ah parameter which we call the COD or the chemical oxygen demand ok. Chemical oxygen demand is majorly most famously used in most of the ah treatment unit, treatment plants all over the world because its precision and the reproducibility and it is also quite easier to perform than the BOD. You remember BOD we need 5 day 3 day it is like longer duration you cannot do it in a regular basis in a in your industry can you do that you cannot. So, what you have to do you can do the COD test COD test does not take more than couple of hour ok.

So, what are the other ah benefits of it? It takes a standardized methods American Public Health Association APHA it is they are very they are actually they made a very specific ah characteristics and the method that is available in their notes and also the international organization of standardization. So, ISO also has its own notes available for the ah COD method that has to be followed by the scientist all over the world or the the testing facilities all over the world. It also has a strict laboratory ah protocols the precise measurement and accurate reagent preparation and control environmental conditions can be kept whereas, in BOD ah your inoculum may drastically vary your performance the BOD value the actual

the BOD value that you will get out of it. Because suppose you are taking an inoculum from the nearby water bodies or definitely there will be a very less amount of microorganisms present there at the same time suppose you are taking it directly from ah aerobic treatment unit which is already running. So, you take the sludge sample from the bottom that is very activated that means, there are huge amount of microbes present there and there are there even the microbes their ah consumption pattern will also differ time to place to place.

So, all these things will give you a little bit of ah range of BOD values the actual BOD is very hard to get because it depends on different different other parameters as well. However, in COD you will get the actual value because it has a very strict laboratory protocols maintains for maintained for it. Then it is also reproducible ah I mean like as I was mentioning also quality control is possible because ah it we can go for the running blank and also identify rectify the issues related to the related to the testings. And the titration accuracy, B-route calibration ah indicator use the end point determination executed with care for accuracy and plus nowadays it becomes much more easier because of the spectrophotometric methods those are available. Sometimes people do not go for this laboratory procedures more like like ah because of like like the spectrophotometric methods are much more easier ok.

In the close reflex method only that I will be discussing, but it is done now in spectrophotometrically most of the places in the world because it is much it makes it much easier and the faster ah determination and the accurate result is possible then the ah then the other titration methods and all. What are the importance of COD in water quality assessment? As I was mentioning BOD gives us the biodegradable organic matter present in your wastewater. COD will give you almost complete organic matter present in a wastewater. Sometimes it may not be able to give the exact value of the organic matter present in a wastewater if there are some very hardly biodegradable organic matter present like the cellulose that we have there there are different types of ah aromatic hydrocarbons which are very hard to break. Only in a very few cases that COD would not be able to give you the exact value of the organic matter present in a wastewater.

So, most of the cases it does. So, that is why the COD is more preferable more ah reproducible and also it is more precise in giving the organic matter present in your wastewater ok. So, the COD it also it definitely indicates the organic pollution in the water as I was mentioning. So, the importance of organic matter is obviously, the pollution you know the more if it is there and also the wastewater treatment evolution same as the example that I was giving you for ah the BOD calculation. In the BOD also if you know the initial BOD, if you know the final BOD we can identify that efficiency of the treatment plant same for same applicable for the COD also and even COD can give you more better

accuracy of and showcase you better understanding about the treatment efficacy ah once the COD is concerned ok.

I mean in in a treatment plant is design is concerned. Early pollution detection is possible and the regulatory compliances are also has to be maintained as I was saying different regulatory bodies has different limitations and they have maintained they standardized and it has to be maintained. So, the COD value of your wastewater COD value of municipality waste wastewater or the water that is that is being discharged into the surface water body or the industrial wastewater the effluent will give the regulatory body a free hand that ok. So, they are not maintaining the COD, they are not maintaining the ah treatment ah plant in a way that it is supposed to be because the final COD is more than what it is supposed to be. So, that means, their treatment has some issues some error some error something ah some mishap is happening some issues are there in their treatment plant you know. How we can determine the COD? There are open reflux methods for samples ah with COD say like around 50 milligram per liter oxygen per ah milligram of milligram per liter or 50 ppm.

The sample homogenization shaking, stirring, using a mechanical homogenizer for uniform mixture prepare the reagent sulphuric acid potassium dichromate silver sulphate ferrous ammonium sulphate and the starch indicator is used. Ah potassium disation procedure potassium dichromate added while mixing ah until the green color is achieved and then silver sulphate is also added as a catalyst and the the cooling and transfer procedure we ah normally use the 150 milliliter of digested samples and we normally titrate it using the ferrous ammonium sulphate which added to the titrate and ah with the excess potassium dichromate and we use the starch indicator for ah end point determinations. Normally the color changes from blue green to the wine red and the calculations can be you can see from you can be easily ah done using this ah the the following equations the COD in milligram per liter is A minus B multiplied by capital N 800 divided by milliliter of sample where A is the milliliter of ah FANH 4 2 say SO 4 2 2 required ah for the blank and the B is the ah milliliter of FANH 4 2 SO 4 2 required for the samples and N is the normality of the ah of the solution of the chemicals ah which is normally the 0.1 normal.

$$COD, mg/L = \frac{(A - B) \times N \times 800}{mL\ of\ sample}$$

So, this is the open reflex method there are closed reflex method also in the closed reflex methods what they do ah the same almost the same procedure I mean like instead of ah say initially we we took the 2 2.5 ml of sample then we put another ah 2.5 ml of ah potassium dichromate and then ah we add 3.5 ml of sulphuric acid with the silver sulphate as a catalyst. So, this reaction this 2.5 sample 2.5 dichro potassium dichromate and put to 3.5 H2SO 4 with silver sulphate at catalyst it will when we gently shake it and put it in the ah digester the COD digester we call it. In the COD digester when it is ah like you know it

goes for say 150 degree Celsius to 160 degree Celsius for 2 hour what it does it digest it do the complete digestion of the organic matter present in the systems. Then we can actually ah do the spectrophotometrically we can measure the at 600 nanometer we try to measure the absorbance value and from that absorbance value we can easily quantify with the existing calibration curve that what is the COD of your sample ok. It is very easy you can actually follow a lot of literatures which are available ah I cannot go through in one lecture it is very difficult to discuss all this in details, but you can easily get it in the ah the close reflex method using spectrophotometric method is one of the best way one of the easiest way of ah doing it ah measure the CODs. In general COD test measures virtually all oxidizable organic compounds whether biodegradable or not except some aromatic compounds which resist the dichromate oxidation I was as I was mentioning and also COD is proportional to the BOD only for readily soluble organic matter ah which is dissolved in the in the wastewater.

If it is not if it is like the complex wastewater there is very hard to find out the correlation between the BOD and COD ok. Specially if the organic matter is present in a suspended from under such situation filter sample should be used because otherwise you cannot justify the BOD and COD ah they they correlation between the BOD COD and also the complex wastewater when it contains some refractory substances. What is refractory substances? Everything, but which is hardly biodegradable substances. For hardly biodegradable substances it is very hard for you to ah find out the ah the correlation between ah this both the the terms. For readily biodegradable waste such as the dairy waste which is ah in general most of the ah you know the the organic matter can be easily digested and most of them are actually biodegradable in nature.

So, in that case COD ah to BOD ratio you can easily find COD is general in generally the BOD ultimate divided by 0.92. The potential sources of interference in the COD test, majorly COD test encounters the ah the the interference likes residual chlorine if it does present in your wastewater. So, we normally what how we can ah minimize it we add the mercury sulfate which will actually ah which will actually remove the interfering ah this chloride ions. Sometimes we do the blank corrections also using the reagent grade ah grade water or a sample ah that does not contain organic matter.

We do the ah regular calibration of the equipment, sample dilution is also needed sometimes and use of standard we use sometimes standard on the reference materials for ah practicing the ah best possible way of ah calculating the COD. Determination of total organic carbon is another which actually gives us a direct and comprehensive indicator of total organic carbon present in a content present in a wastewater. How we can do that? We can do that with the high temperature combustion method widely used and which ensures the accurate measurement of total organic carbon and we can also ah do it using

the sample we can easily do it by you know you know we first remove the inorganic carbon by phosphoric acid or sulfuric acid ah to reduce the pH ah to less than 2.0. And then we homogenize it ensure that the sample is well mixed if it contains any insoluble water or insoluble matter or the solids.

Then we purge the sample in a purified carbon dioxide free gas for approximately 10 minutes and this steps removes the inorganic carbon prepare the sample for TOC analysis. Then we analyze the ah sample the use the syringe to extract the prepared sample and introduce it to the TOC analyzers and all. And we sometimes deduct the procedural blank also by subtracting the procedural blank response from the each samples analysis. And this account for any background interference or it actually gives us the accurate results when we actually eliminate this blank corrections and all. So, in general ah in this particular lecture video we were discussing about the BOD we understood that what is BOD is all about and how this biochemical oxygen demand is very essential ah for understanding the the organic nature of the biodegradable organic nature of your wastewater.

And the COD gives us an idea about the the all the organic matter present most of the organic matter present in your wastewater and TOC gives us the complete picture ok. So, there are rigorous ah standardization quality control measures and skill technicians are needed for ensuring the COD test. However, it gives us the more accurate and reliable result than the BOD ok. So, we will discuss about more in details about the BOD modeling the the the its relation with the COD and the TOCs in the coming lecture. And before that this is the references that I should request you to actually you can I am requesting you to go ahead with this and before going to the next ah presentation I request like you to go through the some materials ah in net only directly to understand more in details about the biochemical oxygen demand and the chemical oxygen demand to go through some of the some additional understanding 1 or 2 research paper.

So, then it will be much easier for you to understand in the coming lectures ok. So, thank you so much I hope you understood ah this very important ah lecture in a very precise way because of the ah this because it is like the foundation of the course I would say this BOD and CODs will be talking about this BOD COD a lot ok. So, nice ah thank you so much see you in the next video.