Biological Process Design For
Wastewater Treatment
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Lecture: 04
Wastewater Characterization - I

Good day everyone and welcome to this NPTEL online certification course on biological process design for wastewater treatment. So today actually we are going to start with understanding how to characterize a wastewater. So if we have to treat any water we should understand that what are the various constituents which are present inside the water which are undesirable.

So during the biological or physio chemical treatment of wastewater we need to remove all these undesirable characteristics of wastewater and undesirable constituents present in the wastewater to a limit so that we can use it for the designated purpose whatever we want to use the wastewater later on. So we are going to study the wastewater characterization in detail in today's lecture.

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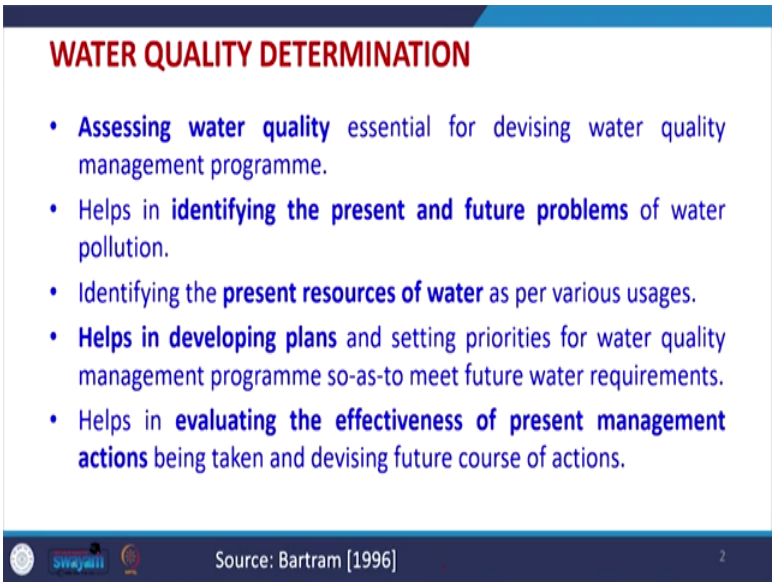

Now the water quality determination or the wastewater characterization this is very, very essential for various aspects first and for most assessing the water quality is essential for devising the water quality management program. It also helps in giving aside ideas what are the provable use of the water that we are getting whether we can use it for drinking, whether

we can use it for bathing, whether we can use it for cleaning are still we can use it for industrial operations or not.

So assessing the water quality is very important depending upon the water quality we can use the water for various uses. Now the water quality determination helps in identifying the presence and the future problems of water pollution. So if we are assessing the water quality for longer duration we can cross check that okay this water which is getting generated or the water, whatever water is we are taking out from the ground we are continuously seeing the change in the water quality characteristics.

So that means in future also the problem will be enhanced and will have to solve the problem in detail. So this helps in identifying the present and future problems of the water pollution. It also the water quality determination helps in identifying the resources of water as per the various uses. So we have to always look for the resources of water depending upon our uses.

So our if our uses are different then the we have to see that how we can use the water. It also helps in developing plants and setting priorities of water quality management so as to meet the future water requirements. So if any city is there its water requirements may be increasing because of the increase in population. So we need to develop a plan for getting water for the enhanced population increased population and for the city itself. So this is there.

Also water quality determinations helps in evaluating the effectiveness of the present management actions that have been taken earlier. And it helps in revising the future course of actions as well. So overall the water quality determination is highly important. Now what are the various principal constituents which may be present in the water or wastewater and these constituents which may be important for us. So for all those persons which are involved in treatment of water.

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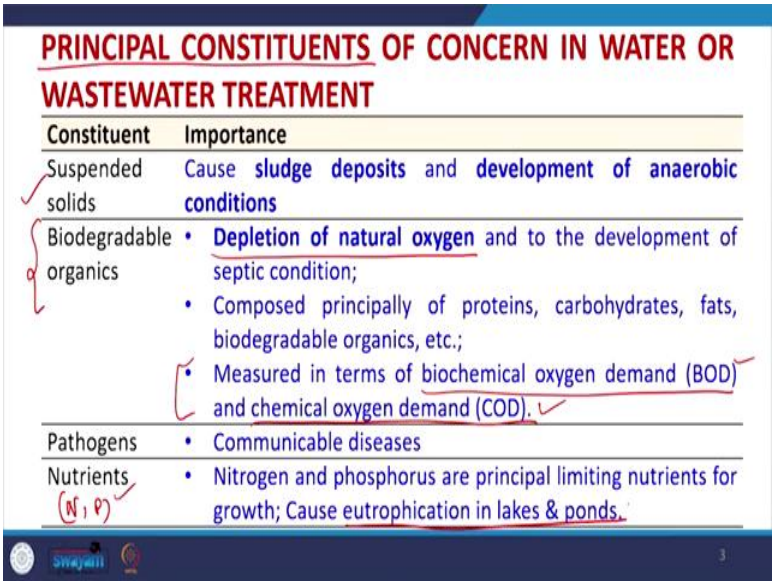

These constituents we must always look for. So first and foremost suspended solid. So if any suspended solid is present inside the water it will cause sludge deposits development or anaerobic conditions if high amount of solid surface and they may be because of hardness and other things. So the water cannot be used for industrial uses also there are different possibilities depending upon the constituent present.

Similarly, if biodegradable organics are present that means the water contains organic matter which can be degraded so that means during degradation they will require oxygen. So we will be having depletion of natural oxygen which will occur when the biodegradable organics are present inside the water and it will cause septic and conditions inside the water because oxygen will not be there. Also the proteins, carbohydrates, fats, all these matter when present in water they will be decomposed.

So we will be forming secondary products are ultimately CO_2 and H_2O and depending upon whether oxygen is available or not available we may form H_2S also ammonia also. So we may have a lot of order formation also happening depending whether aerobic conditions are prevailing or anaerobic conditions are prevailing.

Now all these biodegradable organics are measured in terms of biochemical oxygen demand, and chemical oxygen demand. For biological wastewater treatment this is one of the most important criteria. So will be learning this BOD and COD in detail in today's lecture or later on.

Pathogens may also be present and if they are present they will cause diseases to various persons who are using these waters similarly nutrients if they are present nutrients like nitrogen and phosphorus. So if they are present inside the water they are the principal in nutrients for growth. So they may cause eutrophication of the lakes and ponds and in the longer run it may not be helpful. So we need to avoid release of nitrogen and phosphorus in the wastewater.

Similarly, heavy metals some other types of priority pollutants refractory organics, inorganics may be present and they may be getting added from different sources including industrial activities.

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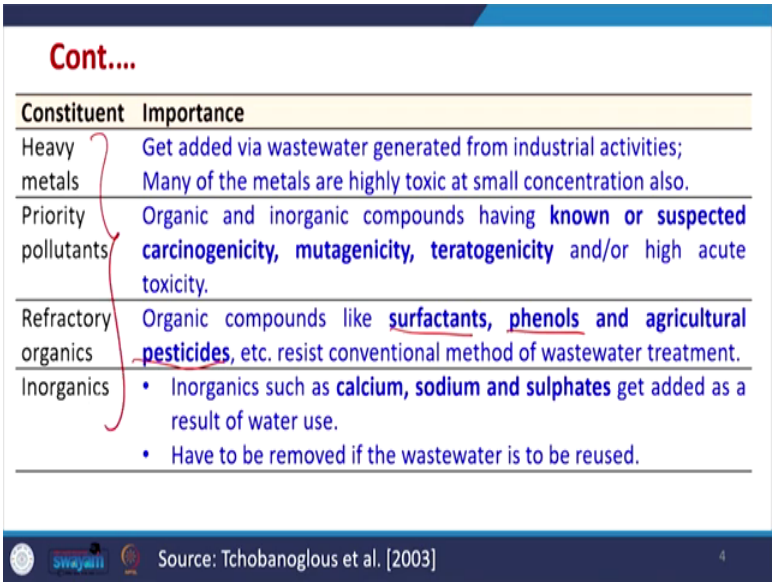

So heavy metals they get added via wastewater generated from industrial activities. Many of these metals heavy metals are highly toxic at very small concentration also. So they make the wastewater totally unusable for various any other uses if they are present. Similarly, priority pollutants may be presence inside the water these may be organic or inorganic compound having known or suspected carcinogenic, mutagenic, tetragenic nature the Teratogenic nature if they are present they will be causing high toxicity and they need to be removed.

Remember similarly we have refractive organics which are not biodegradable. So organic compounds like surfactants phenols and agricultural pesticide, insecticide etcetera they do not get easily biodegrade so that is why they are called refractory as so they cannot be treated in the conventional method of wastewater treatment and they have to be treated further via other means.

Similarly, inorganics such as calcium sodium sulfate they may get added from various sources including industrial sources and they may cause the water unusable for various applications and they have to be removed in the water is to be reused for any uses like in the industry or for cleaning also or for maybe bathing also. So all these materials need to be removed.

Remember some of the materials like biodegradable inorganic or organic material they can be removed via the biological treatment processes other have to be removed via physico chemical treatment process. So already I have delivered a course on physico chemical treatment of water and wastewater and where we have more given emphasis for physico chemical treatment of water and wastewater.

So under physio chemical treatment heavy metals priority pollutants, refractory organics all these are getting removed via various processes. For biological treatment of biodegradable organics is important if the biodegradable organics are present inside the water including nutrients etcetera also then we can go for biological treatment of water.

Generally, the municipal wastewater which is generated in any other community it has more presence of biodegradable organics and it can be treated via biological treatment methods whereas the industrial wastewater which are generated in various chemical and process industries they require physiochemical treatment methods along with the biological treatment method for wholesome treatment of wastewater.

So depending upon the constituents which are present inside the water the treatment methods may be different the constituent present and their quantity help in understanding of what type of treatment process we should adopt for treatment of that particular wastewater.

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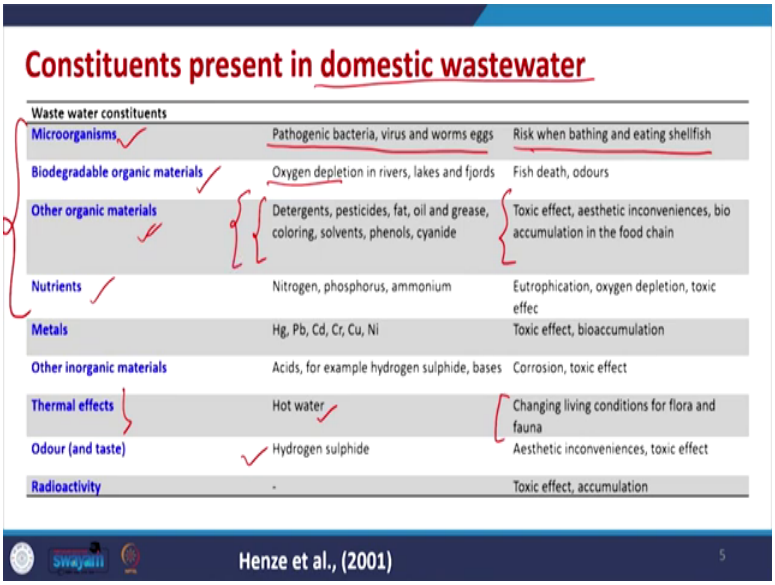

Going further the constituents which are present in the domestic and municipal wastewater, that we are going to study further because they generally contain more biological organic materials and these can be treated via the biological means. So in the domestic wastewater we have microorganism which are present it may be pathogenic bacteria, virus, worms, eggs, etcetera and they may cause risk when we are bathing our eating etcetera. So this is one problem.

Second is that they may contain lots of bio degradable organic material. So they will deplete the oxygen inside the river, lake, reservoir etcetera and the fish death may happen the odours condition may happen because anaerobic condition may prevail because of the oxygen depletion.

Other organic materials which may be presence inside the municipal or domestic wastewater include detergent pesticides, fat, oil and grease, coloring metal solvents, phenol cyanide depending upon that from where they are getting generated. So suppose any city is having a car washery. So from the car washery oil and grease will get generated.

Similarly, some small industry may also be present inside a city premises also just outside the city premises some municipal wastewater which is getting generated it may get some amount of all these materials and we may get all these. So other organic materials so they cause a lot of toxic effect and aesthetic inconvenience because the water will become colored or blackish in nature. So it would not look good.

Similarly, nutrients may be presence like phosphorus, nitrogen, ammonium etcetera and eutrophication may happen metals other inorganic materials may be present depending upon the other industries present in the vicinity or not. Similarly, thermal effects may be there if the hot water the water is at high temperature in particular the water which is generated from thermal power plants it is having temperature much higher than the usual temperature of the water.

So that means the hot water condition may be there under that condition the flora and fauna may change. Odor and taste may also be different though hydrogen sulfide may be present depending upon the anaerobic condition or not. But first 4 conditions are always possible in any domestic wastewater treatment plant wastewater and we have to treat further this domestic wastewater in the biological treatment process.

So biological treatment process generally will be designed to remove all these materials but the other organic material they may get removed or not depending upon their presence and their quantity how much quantity of these things are presence inside the water.

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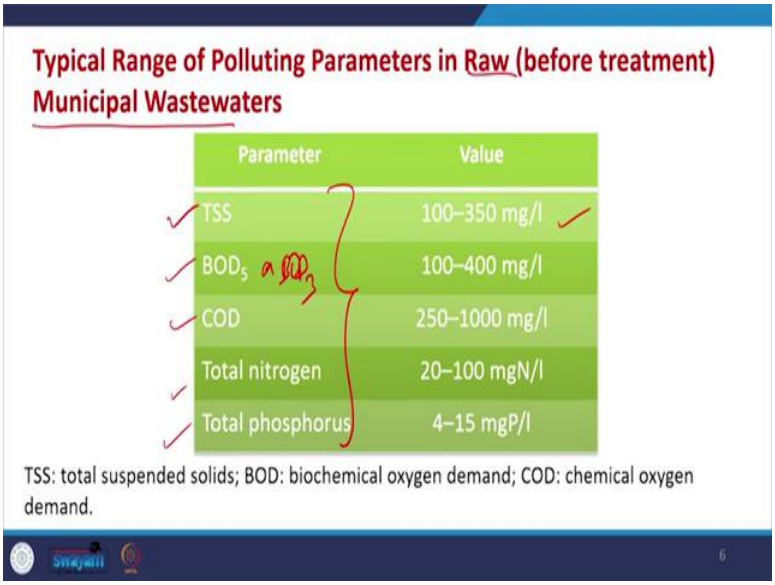

Now the typical range of polluting parameters in the raw municipal wastewater is given here. So we have different parameters which are listed here. We are going to further study these parameters for TSS is total suspended solid BOD is biochemical oxygen demand, COD chemical oxygen demand, and this is total nitrogen total phosphorus.

So for biological treatment all these parameters are very important so BOD_5 or BOD_3, maybe their ranges are given here 100 To 350 milligram per liter for TSS, COD 250 to 1000

milligram per liter certainly it may vary depending upon from where it is getting generated. So all these constituents may be present inside of water. Now we are going to learn how to determine all these parameters and what is the basic understanding of all these parameters before going further.

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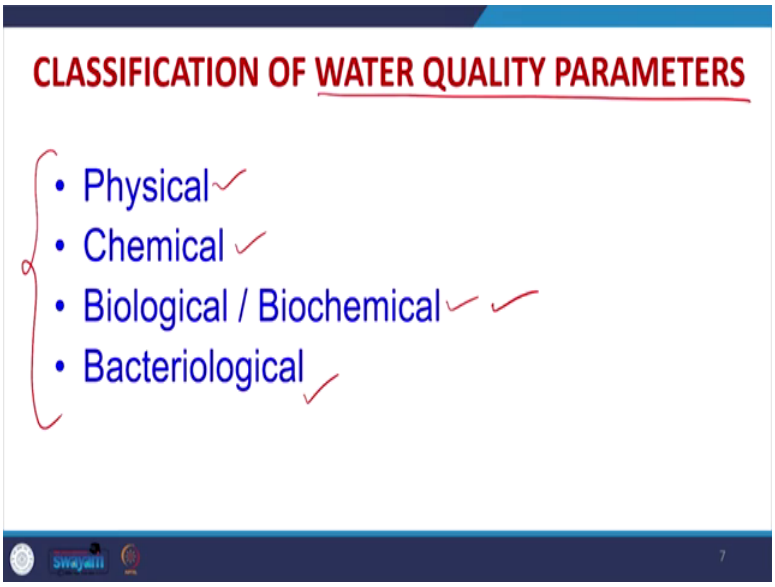

So now we are going to understand the water quality parameters that we have to determine. So there are different types of water quality parameter their classification is different like physical water quality parameter chemical water quality parameter, biological or biochemical and bacteriological. Remember that already I have given lots of lectures related to water quality parameter in another course and physio chemical treatment of wastewater.

So there we have explained all these parameters in great detail in 7, 8 lectures. So we can always go and understand all these parameters in detail here will be just relearning these parameters quickly. And I will be discussing in detail the biological and biochemical water quality parameters in detail because these are of more use to us for biological treatment of wastewater. So if you want to study all these parameters in great detail please see the lectures on physio chemical treatment of wastewater.

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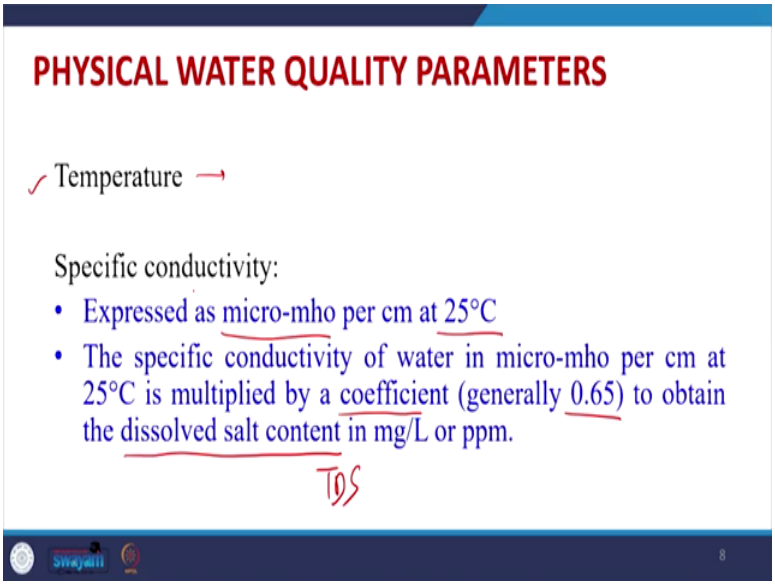

Now physical water quality parameters what are the different physical water quality parameters that we need to determine. So these include first and foremost the temperature, the physical water quality parameters are like those which can be sensed by our sensors. So temperature is one of the parameters we need to determine the temperature of the water, the temperature of water is generally the same as ambient temperature but under certain condition the water coming out from a like thermal power plant, it will be at high temperature.

So we had to see that the thermal pollution should not happen, that is why we should report the temperature of the water at its source. Similarly, the temperature of water also affects the specific conductivity of the water. So that means if the conductivity is there if the temperature is changing for the same water the specific conductivity will also change.

So especially conductivity is expressed as micro mho per centimeter at 25 degrees centigrade. Their specific conductivity of water in micro mho per centimeter at 25 degrees centigrade is multiplied by a coefficient generally it is 0.65, but it may vary from 0.5 to 0.85 around to obtain the dissolved salt content in milligram per liter.

So remember the specific conductivity there are different types of simple equipment's which actually they measure their specific conductivity, but they multiply it by coefficient and they directly give the value of dissolved salt content, which is called as TDS. So we can always see that the TDS value but actually it is that simple equipment actually measure the specific conductivity and from that they report the TDS values.

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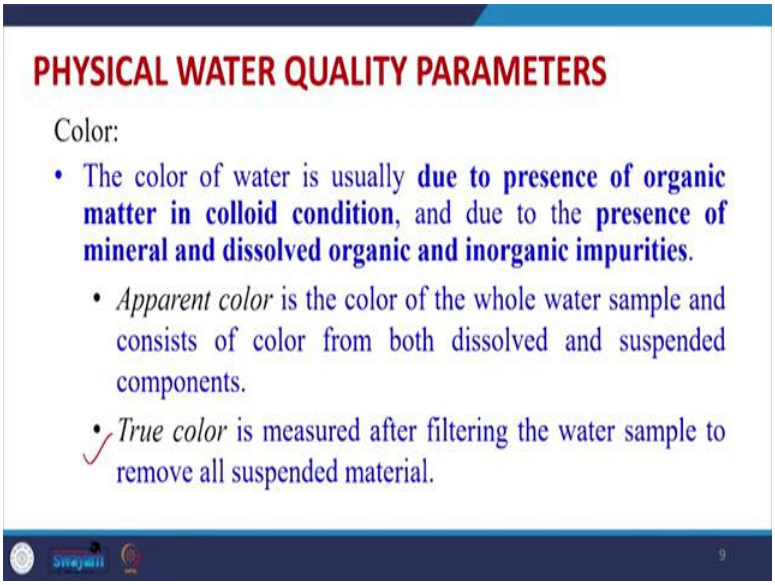

Then in the physical water quality parameter color is also an important parameter and color is also important for biological treatment of water also in particular if the water is generated in industry like textile and we are performing some water biological treatment process so we have to measure the color removal efficiency etcetera also. So color measurement is very important and color removal efficiency measurement is for most important for treatment process.

Now the color of water is usually due to presence of organic matter in that colliders condition. So as various types of organic matter get dissolved in the water and they impart color due to the presence of minerals dissolved organic and inorganic impurities they also impart color to any of the water.

Now the color is further classified as apparent color or true color. Apparent color is the color of the whole water sample and it consists of color from both dissolved and suspended components. That means if suppose we are taking out water from any source and so will see some color so that will be apparent color.

After some time, it may be possible that the suspended components they get settled down and water after some time its true color will come out because all those suspended materials are getting removed and they are settling down to the bottom. So will be getting true color. The true color is measured after filtering the water sample to remove all the suspended material so that will give the true color are the water.

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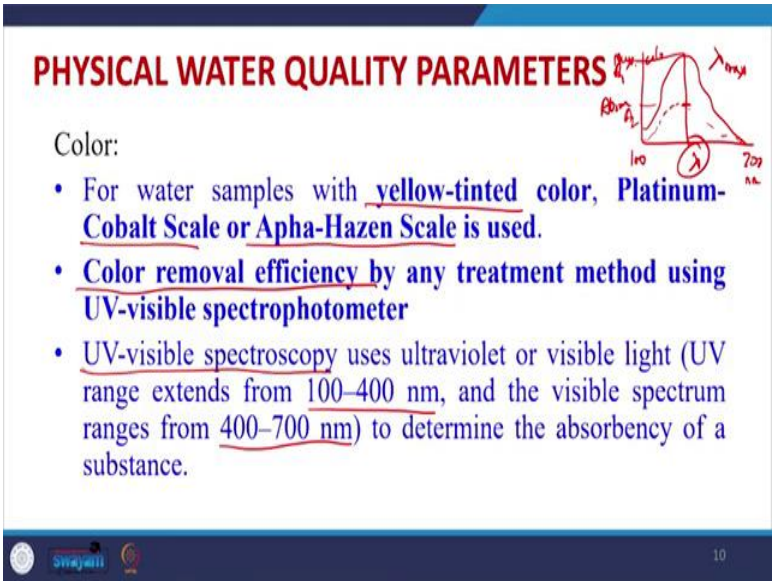

For water samples with yellow tinted color there is a method which is used for reporting the color of the water. So if any water which is yellow tinted remember it is for yellow tinted color. So the platinum cobalt scale is used and it is also called Apha-Hazen scale. So remember it was given by Hazen and it is used for reporting color of the water samples with yellow tinted color. So this and the instrument is also available for this.

Now if we had to determine any other color so it is very difficult to remove the color of the water in actual way we generally use UV visible spectroscopy method which actually uses ultraviolet or visible light. So UV range extends from 100 to 400 nanometer and the visible range extends from 400 to 700 nanometer.

So this whole UV visible range from 100 to 700 nanometer is used to determine the absorbency of a substance or of a water sample. So what we do is that we can take water and we determine the absorbance of the water at different lambda and this lambda will vary from 100 to 700 nanometer.

Now this may change like this. So what we report generally is the lambda at which maximum absorbance happens. So this is called lambda max, this is not the maximum value of lambda, this is the value of lambda in the UV visible range at which maximum absorbance occur for that water. So this is will be the tentatively the color of that water. So the lambda value gives the idea that what is the tentative color of that water.

And the same technique actually is used for determining that color removal efficiency by any treatment method. So what we do is that we determine the lambda max of that water before

treatment. And we note down the what is the absorbance a suppose this is A1 after treatment again will try to find out that absorbance of the water at that lambda itself which is the lambda max.

So suppose the water after treatment comes out like this so will be getting a second lambda which is A2. So from A1 and A2 value we can determine the color removal efficiency of any wastewater treatment method going further similar to color there is another parameter which is called turbidity.

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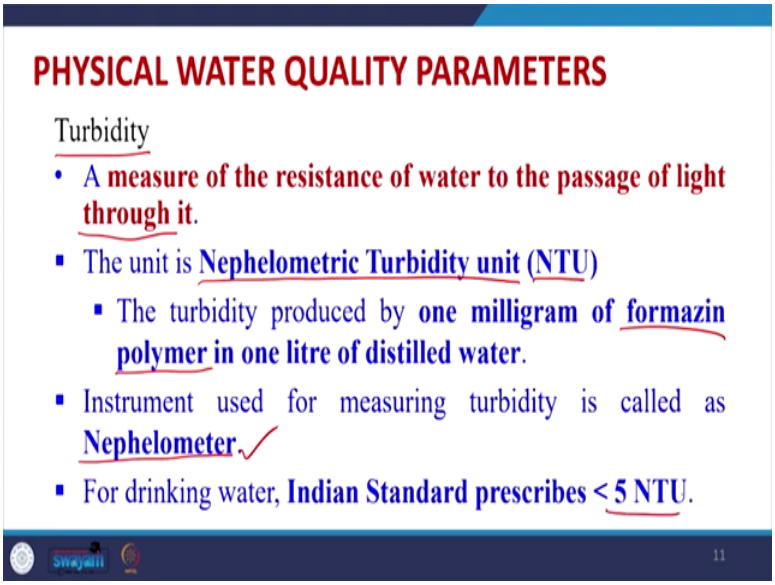

So turbidity actually measures the resistance of water to the passage of light through it. So we have how much light is absorb while the light is passing through the water samples that is given by the turbidity. Now this turbidity is measured in terms of unit which is called NTU, NTU means nephelometric turbidity unit and that turbidity as 1 NTU is the amount of unit which is actually produced by 1 milligram of formazin polymer in 1 liter of distilled water.

So whatever if suppose the formazin is dissolved in 1 liter of distilled water and that sample is measured and that sample the resistance is measured by a nephelometer then we can find out the 1 NTU. So that will be given 1 NTU and all the turbidity for other water samples is measured using nephelometer, we always want the turbidity in terms of NTU to be minimum possible for drinking water Indian standard prescribed the water to have less than 5 NTU of turbidity then only we can use the water for drinking purpose.

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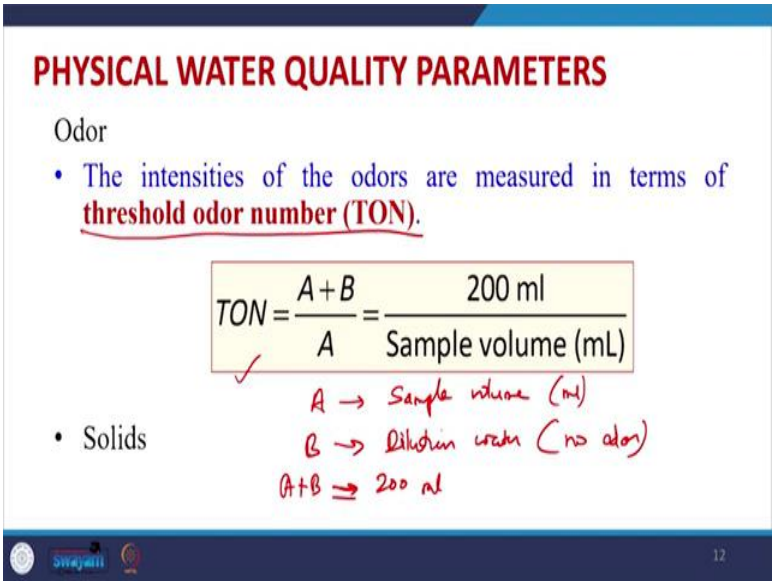

The intensities of the odors are measured in terms of **threshold odor number (TON)**.

$$TON = \frac{A+B}{A} = \frac{200\ \text{ml}}{\text{Sample volume (mL)}}$$

Then there is another parameter which is called odor. Now there are odor of a water sample is very difficult to measure. So there is a 1 parameter which is called threshold odor number TON now TON is actually defined via this particular equation which is given here A plus B divided by A, here actually the A is the sample volume. So we have A sample volume which is measured in ml and what is done is that this sample volume is always diluted by a dilution water which is not having any odor so this water is not having any odor.

Now this sample volume is diluted with this dilution water to make the sample equivalent to 200 ml. So this A plus B is always equal to 200. So this is how we this TON report and now how to determine that TON what is done is that, that the sample water sample is taken.

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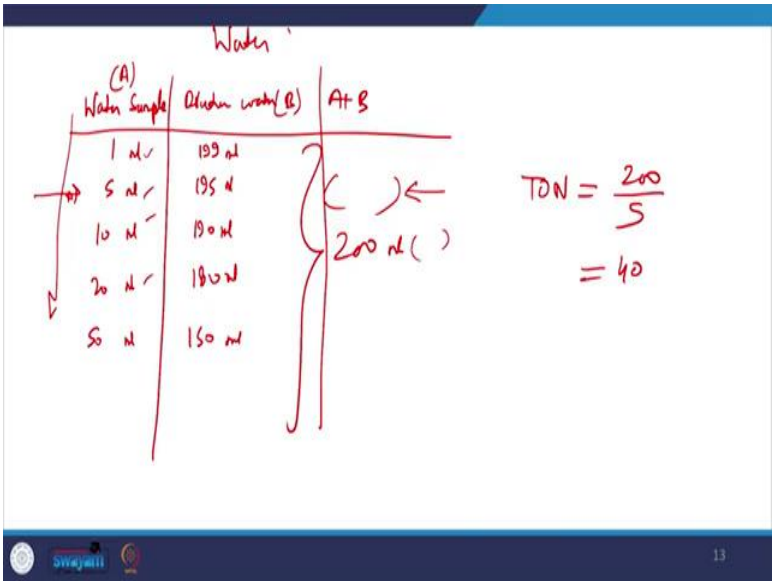

So we have different types of water sample which are taken. So it may be start from taking suppose 1 ml, 5 ml then 10 ml, 20 ml like this we can take larger amount of water sample then this is the value A then we have the dilution water which is the value B and this is taken now this will be here it will be taken as 199 ml so that A plus B is always equal to 200 ml this should be there. So here it will be 195 ml here it will be 190 ml and then similarly 180 ml 150 ml.

So always they will be taken in such a manner that total A plus B value is 2 this now what is done is that a few persons are like taking and they are requested to check whether under from which sample some odor is coming out. So people will start from here. So it is supposed 10 people are there and some are telling that from this A plus B sample some odor they are able to perceive.

So that means this is that because majority of people are reporting the certainly they are getting odor from this sample they will always get odor from other samples. So we always report the minimum diluted water which is having some odor. So that means TON of this particular water sample for which different samples were taken in different amounts. So for this that TON will be 200 divided by 5 that means it will be 40 is that TON of this water sample.

So we studied this way that TON is reported we can find out other water quality parameters like solids also. So will be studying in detail within the physical water quality parameter. What are the different types of solids which are present and how they are reported? Further

will be studying the chemical water quality parameters, biochemical water quality parameters in the next lecture and onwards. Thank you very much.