Physico-Chemical Processes for Wastewater Treatment

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Lecture - 09

Water Quality Monitoring: Bacteriological Parameters

Welcome to this lecture on Water Quality Analysis or Water Quality Monitoring in this course. So, we are continuing with our system of understanding the various water quality parameters and in the previous few lectures we understood that what are the various water quality parameters with respect to physical parameters, then we studied chemical parameters and in the previous class lecture we studied the various biochemical parameters or the parameters which are necessary with respect to estimating the oxygen demand which will be incurred because of the degradation of organic matter present in the water or wastewater.

Now, we are going further for understanding various bacteriological parameters, which may be because of the presence of various micro-organisms and in general the pathogens which may be present in the water. There is one thing that we must understand that these parameters are not commonly estimated by the common water chemist et cetera or because these parameters require a special care as well as lot of precautions have to be taken while performing these tests.

And they are very necessary but if they are required actually they are done in only sophisticated labs which are there and where the expertise are there with respect to estimating the bacteriological parameters within the water or wastewater and generally it is assumed that the industrial wastewater which are discharged they are very less chances of having bacteriological parameter estimation because all the pathogens and viruses will are likely to be killed by the various toxic compounds which are already present in the those wastewaters which are discharged from the industries. So, why bacteriological parameters have become important because lots of diseases have come and which have, which are getting reported and which are related to water.

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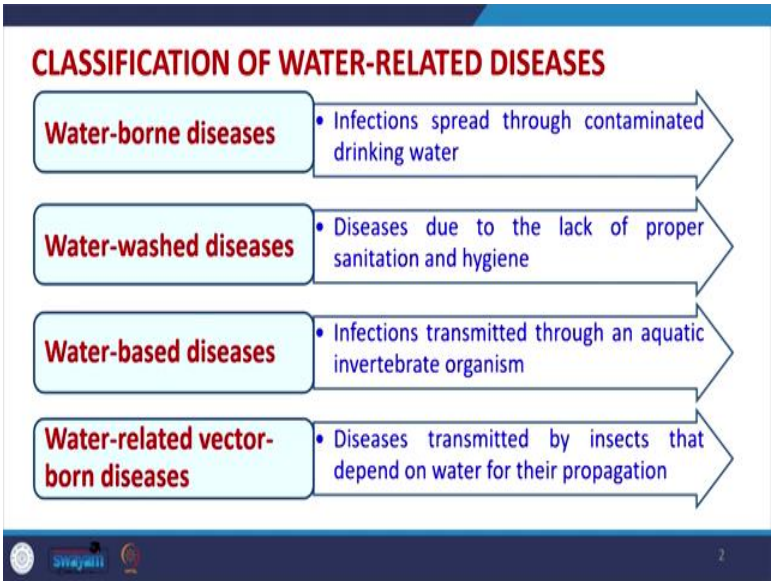

And there are certain classification of diseases which is related to water and these classification is like water borne diseases, water washed diseases, water based diseases and water related vector borne diseases. So, there is some difference between these water related diseases, water borne diseases is related to infections that is spread through contaminated drinking water.

So, if there is any micro-organisms fecal or anything which is present in the drinking water and that drinking water is being used in the communities of water-borne diseases will be there, then water washed diseases, this is due to the lack of proper sanitation and hygiene. So, this is more common, this will be more common in slums in those areas where there is lack of sanitation and hygiene.

So, if this is there, it will be called as water washed diseases, then there is water based diseases, this is, these are transmitted by invertebrate organisms which are dependent upon the aquatic conditions. So, actually they grow in these conditions and they transmit the disease. So, these are called water based diseases, then water related vector borne diseases. So, diseases transmitted by insects, but that depend upon water for their propagation. So, they are called as water related vector borne diseases.

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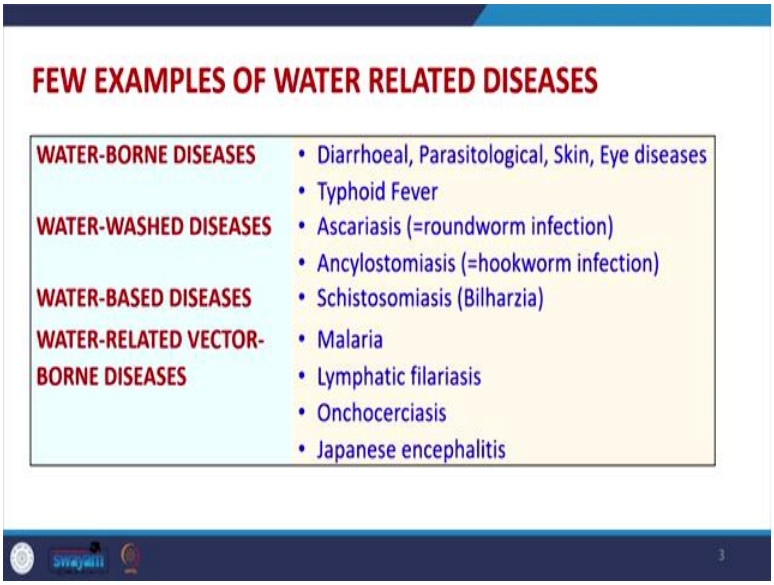

And some of the examples are given here. So, like diarrhoea, then parasitological, skin diseases, lots of eye diseases and typhoid fever, this is related to water-borne disease. Then, Ascariasis this is like round warm infection, then Ancylostomiasis which is like hookworm infection. Then lots of other diseases are there, which is like Bilharzia, which is water based diseases, then malaria, Filariasis. Onchocerciasis, Japanese encephalitis.

So, these are the like water borne, water related vector borne diseases. Now, if you have to estimate that these diseases are occurring by which means, we have to estimate a number of parameters, but estimating these parameters bacteriological parameters is not easy we require a lot of pathological instruments and other things for estimating the relationship between the diseases which are occurring and whether which type of diseases it is whether it is water borne, water washed, water based or water related vector borne.

So, this is very tedious for common water chemist if we make also. So, under that condition only few parameters are estimated by general water chemist which can be easily be performed in common labs. Otherwise, if you have to perform detailed analysis we have to go to a highly sophisticated lab, generally pathological labs.

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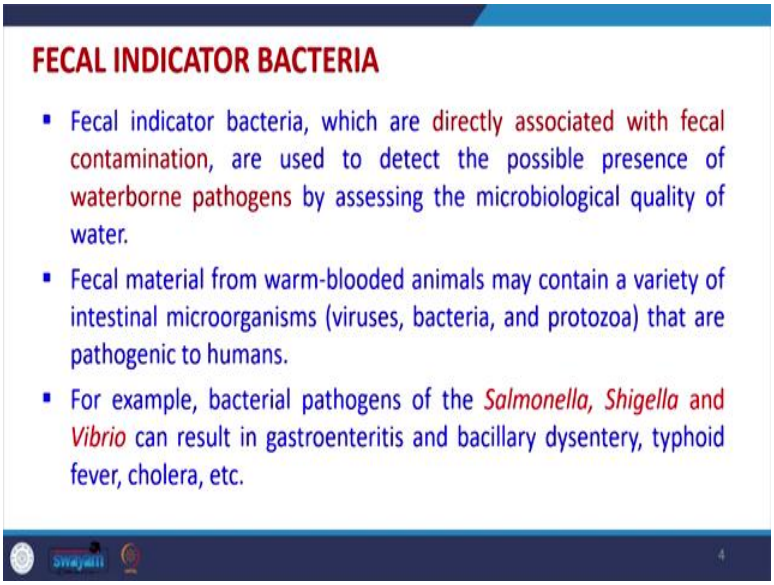

Now, which are the common indicator bacteria which tell there are pathogens present, there is fecal present and that if we take that water it will cause problem and the estimation of these things is very important, where common people get in touch with water in addition to drinking that. So, drinking is one of the key things, but in addition to drinking if suppose, we are using for water for bathing, so, any common festivals which we have in India.

So, many festivals are related to bathing common community bathing in rivers like Ganges. So, for under those conditions before actually bathing occurs, we should perform these tests to check whether the water which is there it is good enough for bathing or not similarly, all those water parks which are there, they have a lot of problem and for there also the daily testing should be done for determining that whether faecal indicator bacteria's or these pathogens are present or not. So, and if they are present, what is their concentration?

So, this is very important. So, fecal indicator bacteria it is directly associated with the fecal contamination and it is used to detect the possible presence of any water-borne pathogens. So, by assessing the fecal indicator bacteria, we can know that okay, whether that water is good enough for further uses or not.

So, fecal material from warm blooded animals may contain a variety of intestinal microorganisms, like virus bacteria, protozoa and that may be pathogenic to human beings as well. So, and these bacterial pathogens include like Salmonella, Shigella and Vibrio and these

can result in a lot of common problems like gastroenteritis, then dysentery, typhoid fever, cholera. So, all these diseases occur because of these bacterial pathogens and we should always estimate these pathogens in the water. So, we should determine the fecal indicator bacteria in the water.

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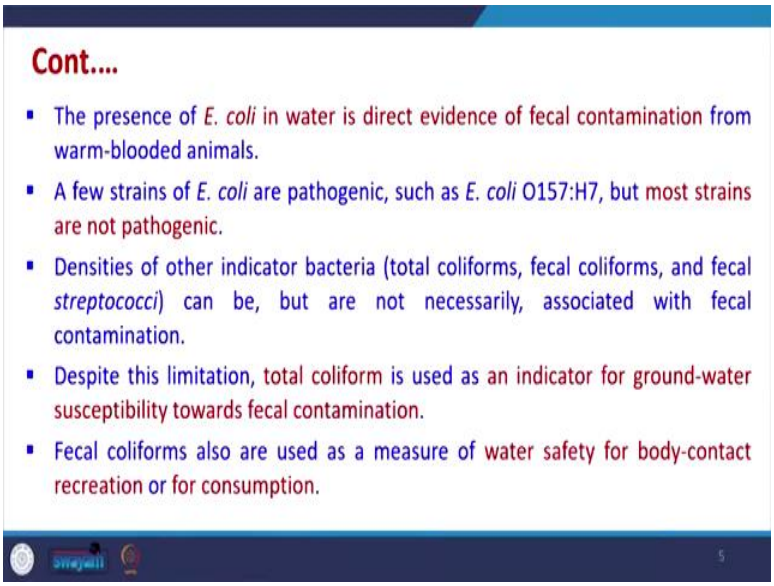

The presence of equally E. coli. E.coli very common and it is the one of the common bacteria, which is estimated, is direct evidence of fecal contamination from some warm blooded animals, which may include human beings as well. And a few strains, only a few strains of E. coli are pathogenic, but if E. coli is present, that means fecal contamination is possible. So that is why E. coli is one of the first thing which is estimated in the water. Most of the strains of E. coli are not pathogenic, but it is present tells that okay, fecal contamination is possible.

Now, densities of other indicator bacteria's like total coliform, fecal coliform and fecal streptococci can also be estimated it they can be associated with fecal contamination and they may not be associated also, but they are also estimated most often. The total coliform is used as an indicator for groundwater susceptibility towards fecal contamination also and total coliform count is also done, which is like MPN most probable number and during the water quality parameters that we studied earlier it was one of the water quality indicator total coliform which is used for determining whether any water is good enough for bathing or not. So fecal coliforms are

used as a measure for water safety for body contact, recreational activities in water parks and other places and also for consumption as well.

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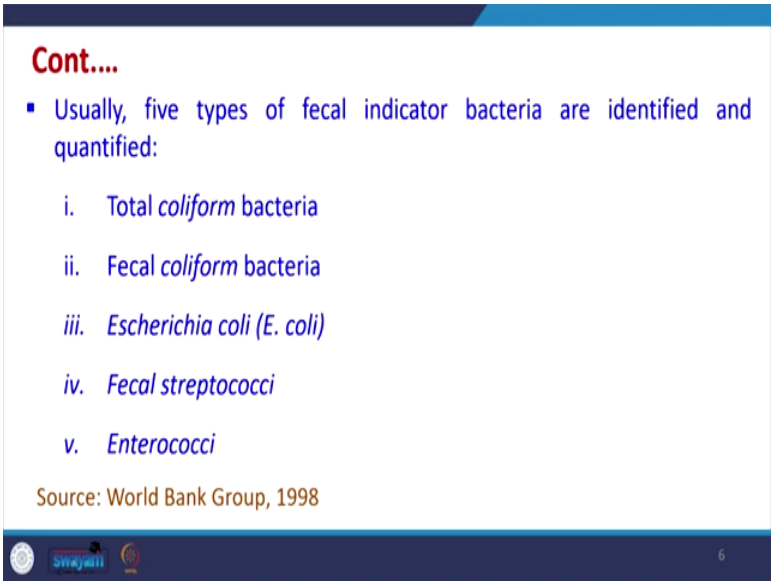

Now, usually five types of faecal indicator bacteria's are identified and quantified and they are like total coliform bacteria, fecal coliform bacteria, E coli, fecal streptococci and enterococci. So, this is, these can be estimated.

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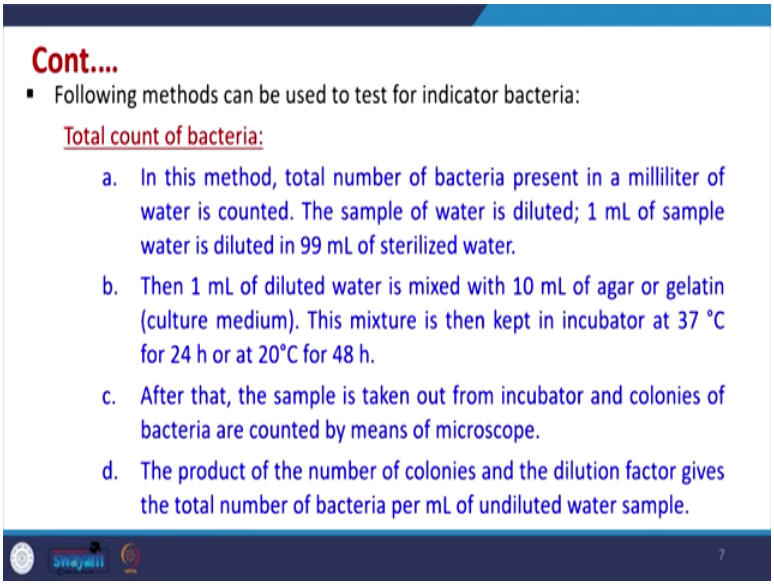

Now, for some method is used for determining the indicator bacteria. So, in this method, what is done is that the for finding that total count of bacteria the total and generally it is estimated that

in millilitre of water, how much is the count. So, the sample water is generally diluted so 1 millilitre of sample water is diluted maybe 90 with 99 ml of sterilized water or maybe beyond that also.

And then further 1 ml of that diluted water is mixed with 10 ml of agar or gelatin and then this mixture is kept in a incubator at 37 degrees centigrade for 20 hours 24 hours or at 20 degrees centigrade for 48 hours and after that the sample is taken out from the incubator and colonies of the bacteria are counted by means of microscope.

And the product of the number of colonies and dilution factor, it is possible that we may require additional dilution also. So, first time diluted water may further be diluted second time and for that also we may perform these counts with respect to number of colonies and from that we can report the how much number of bacteria per ml of undiluted water sample are present, this is there.

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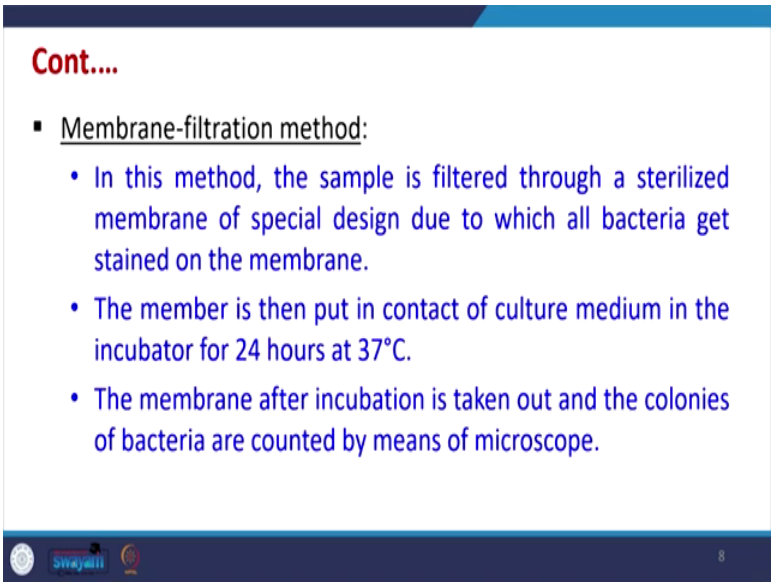

There are some filtration methods also in that the sample is filtered through a sterilised membrane of the special design and because of which, all bacteria get strained on the membrane, and the membrane is then put in contact with the culture medium in the incubator for 24 hours at 37 degrees centigrade and after that, the colonies of bacteria are counted by means of microscope.

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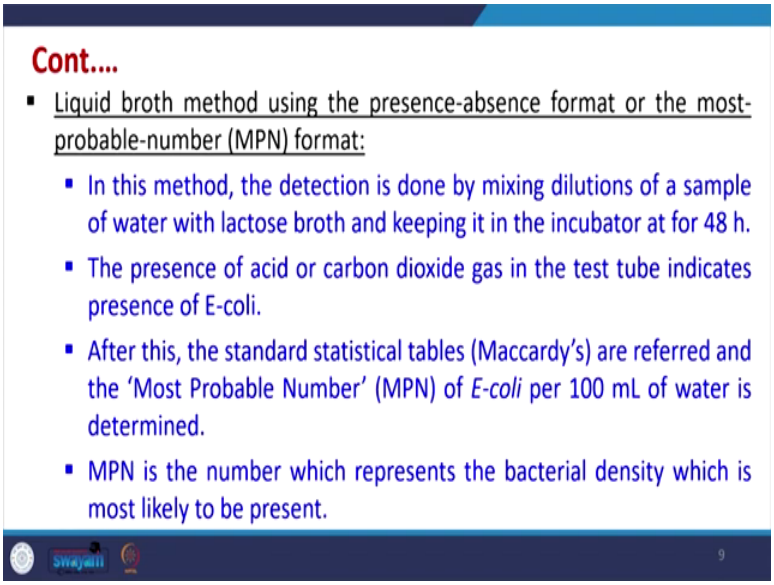

Now, the liquid broth method is used for finding out the presence or absence of the most probable number. So, MPN number is very common method for reporting the presence of bacteria or E. Coli in general and in this method the detection is done by mixing the dilutions of sample of water with lactose broth and then it is kept in the incubator for 48 hours.

The presence of acid or carbon dioxide gas in the test tube indicate the presence of E. Coli. After this the standard statistical tables are there which are referred and most probable number is determined and it is reported in per 100 ml of water and actually the MPN represent the bacteria density which is most likely to be present and through this MPN actually we estimate that whether the water quality is good enough for bathing or not.

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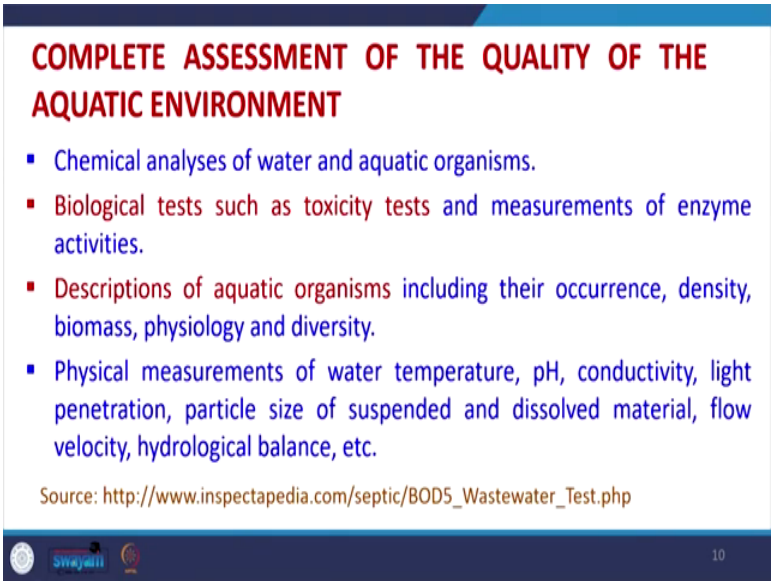

Now, so, these are the various tests we should always perform complete assessment of the quality of the aquatic environment or water and for this, we have understood various types of tests which have been performed. So, any water has to be tested which should perform the chemical analysis of water and various organisms which are present, then biological tests are also possible where toxicity is tested.

And we can also test the enzyme activities, toxicity tests are very easy as compared to enzyme tests so for which a specialised persons are required. Also, we can report the aquatic organisms which may be present they are occurrence density, et cetera. And along with that, we can report the physical measurements with respect to water temperature, pH, conductivity, light penetration test et cetera. So, all these can be reported for complete assessment of the quality of the any aquatic environment, which has for which testing is being done.

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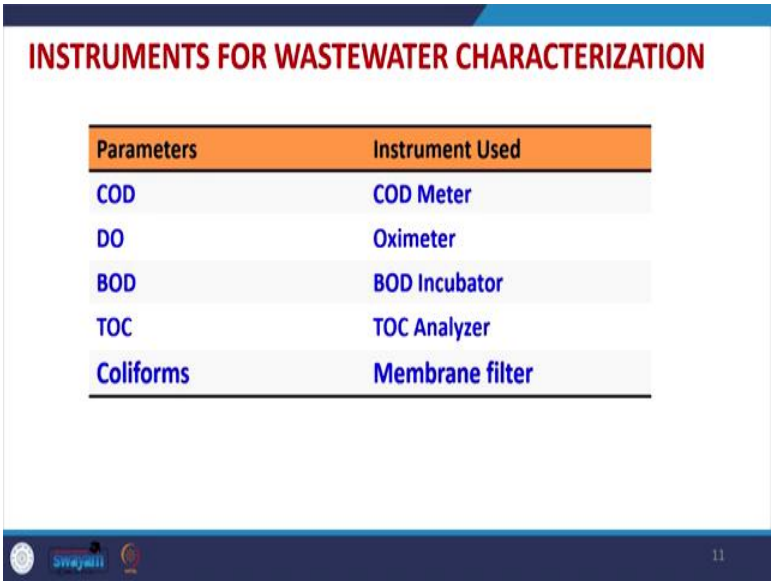

Some of the instruments which are being used in biochemical and bacteriological tests include like COD metre, we can use oximeter for DO determination, we require a BOD incubator for performing the BOD test, because the temperature has to be maintained between certain degree centigrade and we have to see that all the time electricity is there which is being supplied to this BOD. Because anytime if electricity is not there our test will fail.

And after three days we are feeling that okay we are to do it again. Also TOC analyser is very costly and it is required for estimating the TOC for finding out the coliforms membrane filters and various other equipment's are required and for performing any bacteriological tests. So, lots of precautions are there. Overall till now, we have studied various water quality parameters to which can be used to assess the water quality and the summary is being given here.

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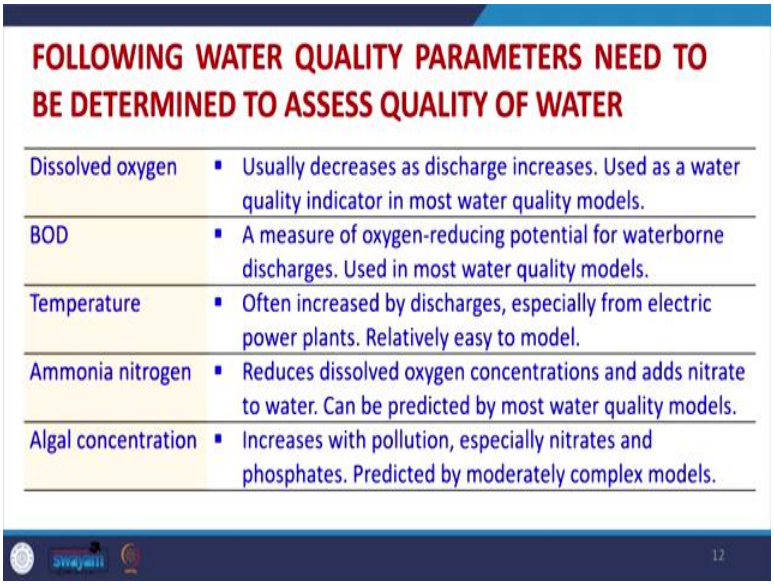

And one of the foremost parameter is dissolved oxygen. So, already told that around 20 degrees centigrade, that dissolved oxygen value is 9.1. But if it is the temperature is increased, so, that dissolved oxygen value will decrease. So, that is why it becomes very important parameter if dissolved oxygen is less than the water, the life in that water will also get affected because of decreased oxygen.

So, dissolved oxygen is very important, BOD, COD are good methods for finding out that what will be the oxygen requirement if any organic containing water is discharged has to be discharged, what will be the oxygen demand? So, higher the oxygen demand that means that lot of organic compounds are present in that water and treatment of that water will be challenging. If BOD to COD ratio is lower that means, there are a lot of compounds which cannot be degraded by micro-organisms which are present in that water.

So, that means we have to go for physico, chemical, thermal electro chemical treatment other than biological treatment either before biological treatment or after biological treatment for removing the overall oxygen demand or the organic matter which is present in that. Temperature is important parameter only for because many of the practical things which are there depend upon temperature like solubility of the oxygen, CO_2, et cetera. So, that depends upon temperature. So, temperature becomes very important and it becomes more important for power

plants. Because they have to take water from any canal or river and then discharge the water at higher temperature.

So, they cannot increase the temperature beyond a certain 10 degree limit which is, which has been imposed. So, that factor is there ammonical nitrogen is also very important parameter because it tells the idea regarding the nitrogenous compound present in that water and we will require additional amount of oxygen also it will be incurred because it will get converted into nitrate. So, this is very important. Algal concentrations if they are present especially, then they affect the overall treatment process because and also they consume CO2. So, algal concentration also sometimes becomes one of the good parameters to estimate.

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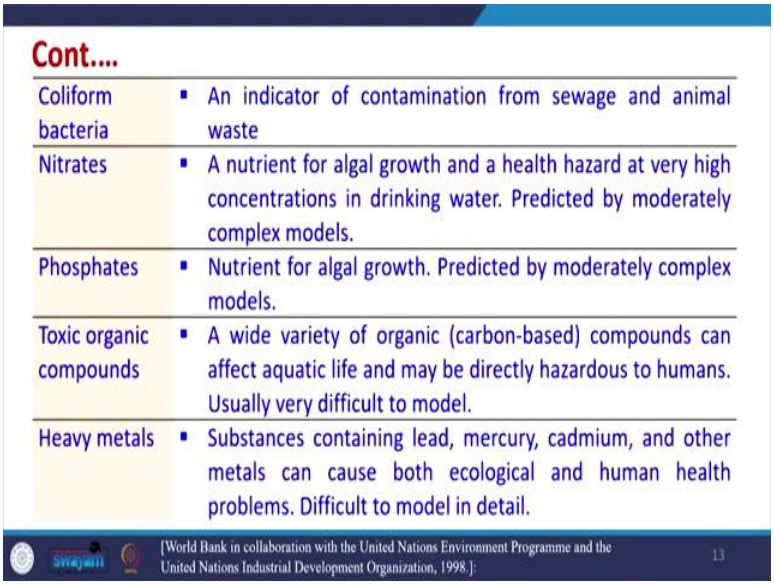

Then coliform bacteria already we discuss nitrates, phosphates and nitrates, phosphates are like nutrients. So, we do not want nutrients to be discharged into the water bodies of because if the nutrients are present in any water and that water is further discharged into another water bodies so nutrient will be increasing and if nutrient increases then eutrophication and other thing happens.

So, any in many of our cities like all those cities, which are called as lake cities. So, there are all the water which is discharged into the lake, we have to cross check that nutrient is not high and nutrient have to be removed before discharging any water into those water bodies, this is very important.

Certainly presence of any toxic or any compound, including heavy metals et cetera is not desirable. These are difficult to estimate compounds. So, many times we require a lot of sophisticated instruments to understand that whether these compounds are heavy metals are present or not and they have lot of effect on the those human beings who are consuming those water where these things are present. So, it is very important to estimate these things at very low concentration and sometimes and it is more true for groundwater and all those water which are used for drinking. So, this is there.

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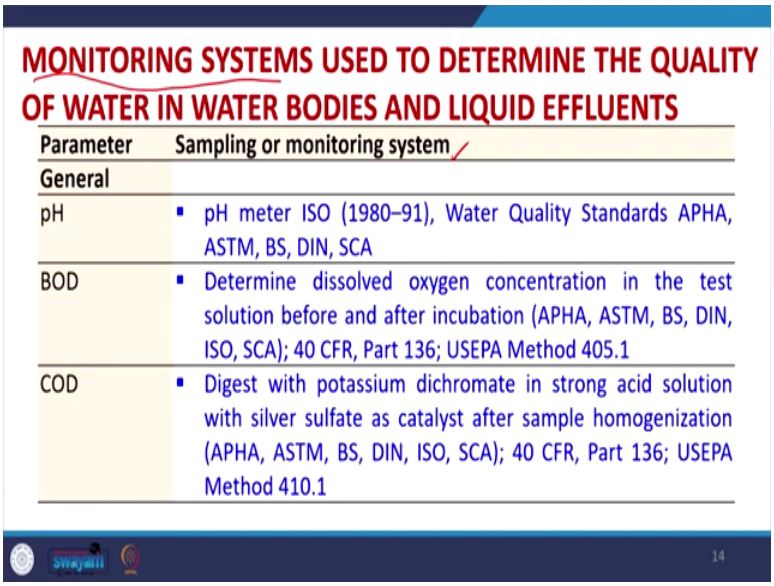

In addition, there are other parameters also like pH, BOD, COD already estimated. These are the various monitoring systems which can be used for determining the quality of water in water bodies and liquid. So, these are monitoring systems like some of them are like specified by WHO, ISO and these are the various methods which are there, if anybody wishes, they can go on further to use these methods for determining and they can further study in detail all these methods, they all cannot be covered in this course. So, just an idea is given that how is the sampling or monitoring or determination of these parameters is done by these methods.

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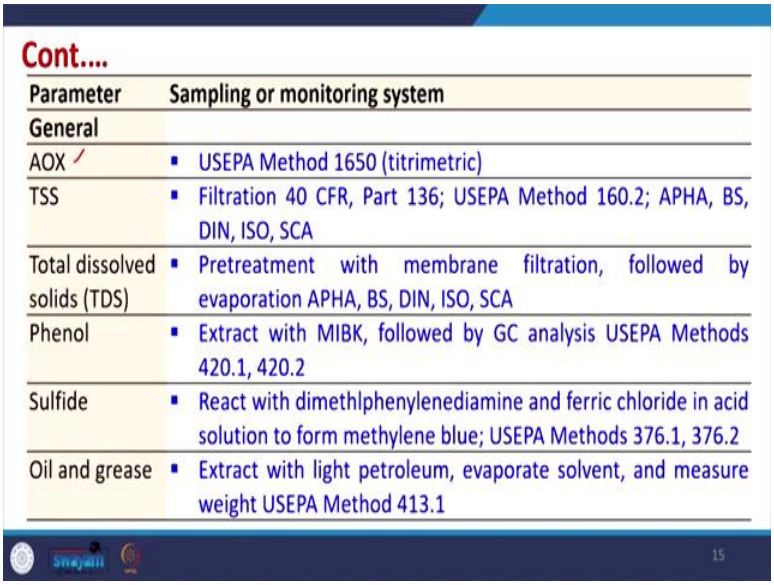

These are being compiled here for AOX. AOX is called absorbable organic halides, so if any halide is present in the water AOX is the parameter and halide means halogens. So, halogens are the most toxic element among all because they require only one electron to complete their valency and they are always looking for that. So, that means they can react with anything. So, we do not require halogen to be presenting any water. So, that can be estimated using AOX. So, there are AOX analyser also, also we can use some titrimetric method is the method which is given here.

Then total suspended solid, total dissolved solids, phenol, sulphide, oil and grease is one of the important component for the water which is coming out from places like where petroleum things are there, petroleum refinery, petrochemicals, et cetera or where benzene, toluene, xylene are all those vehicle washeries which are there. So, all these cars vehicles wherever their washing is done from their oil and grease can come into water. So, they need to be estimated. So, this is the standard method which is there.

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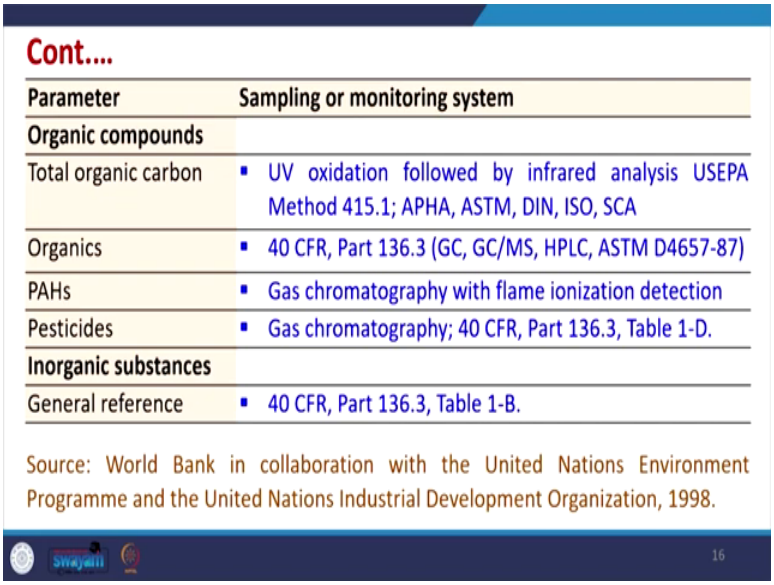

Similarly for organic compounds, there are standard methods which are given here. So, and these methods keep on changing so United Nations, WHO these organisations our CPCB they always give idea that which method is the reference method for estimating these parameters.

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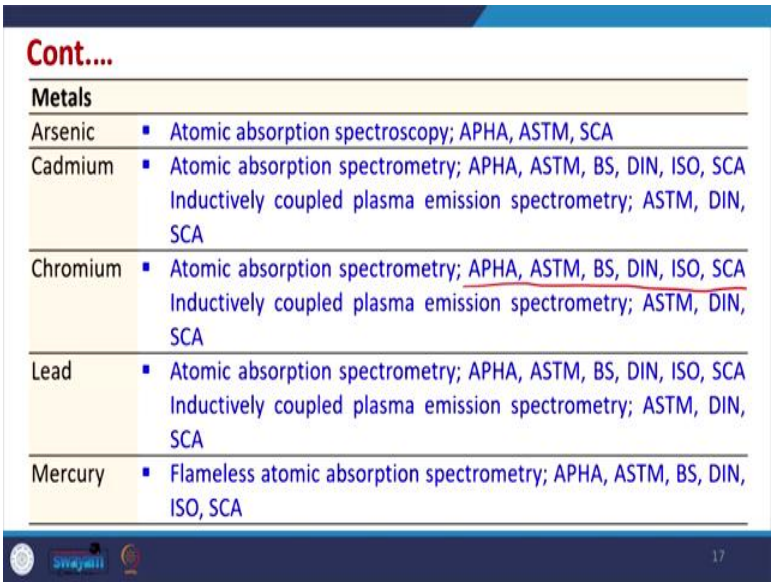

So, similarly, some instruments already we have discussed, so many instruments et cetera can be used and these are specified in standards for different industry, different countries. So, all these are standard methods you can see American public health association ASTM, BS bureau of

standards, so ISO, so all these standard methods are there, they can be used for estimating all these parameters.

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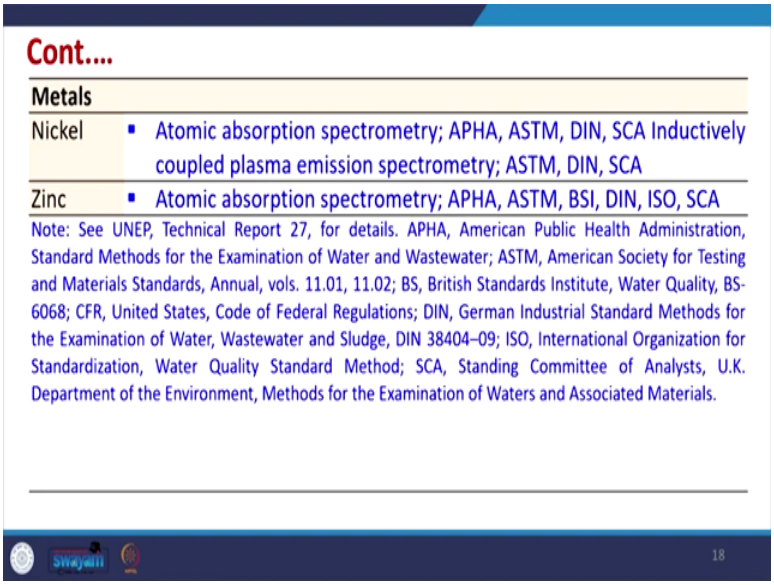

We will not be going further into estimation of parameters by these instruments. If anybody wishes, they can further go on and find out the method how to estimate these the concentration of these metals and elements, inorganics, organic et cetera in the water. So, this can further be studied through this we know we will end the section on water quality monitoring or estimation of parameters in any water.

Next lecture onwards, we will be going for understanding various treatment methods. So, in general, first, we will be studying what is the how the treatment is done in general and then we will study each of the treatment methods in detail. Certainly the actual treatment method, or the actual sequence of treatment methods depend upon a number of parameters. So, we will try to learn all those things in next lecture onwards. Thank you very much.