Physico-Chemical Processes for Wastewater Treatment

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Lecture 03

Water Quality Monitoring Physical Parameters

Good day everyone and welcome to this third lecture of this course on Physico-Chemical Processes for wastewater treatment. In the previous lecture, we found out that there are various agencies which actually take care of the environment and the water pollution, etc. And these agencies include central pollution control board, state pollution control board, and various other agencies.

Now, these agencies have made certain standards and protocols which have to be followed by these industries while discharging the water from their premises after treatment into any other place, which may include the other aquatic water bodies for use in agriculture for discharge into marine or coastal areas, etc.

Now, while studying, we found out that there are number of parameters, which are listed, which have to be monitored, before treatment as well as after treatment, before discharge, and these parameters have to be met as per the maximum concentration values, whatever have been said by the these pollution control agencies.

So, now, we understand that this is very essential that we must understand what are these parameters and how they can be determined and what is the significance of these parameters, until unless we understand the significance and how they are determined, it may not be good enough for us to determine the probable technologies that have to be used. And also, it may be difficult for us to understand the basic science behind the treatment of these parameters by those technologies.

So, water quality monitoring in a way is very important. And water quality monitoring is the main thing that we are going to learn this will continue for three, four lectures at least because these water quality monitoring parameters are a large number of parameters are there and we must understand each of them.

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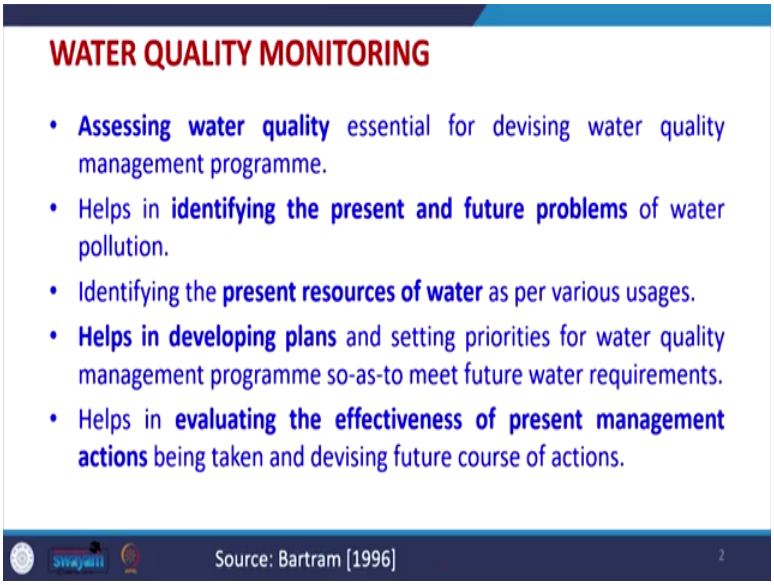

Now, why go for water quality monitoring. So, it actually helps in assessing the water quality and which is essential for devising Water Quality Management Program. So, if you know what is the water quality that we are taking from the river or lake or from groundwater, then also we can determine that whether we can use them directly or we have to treat them before actually using in our residential places or in the industry.

And similarly, after treatment also, we can find out that what is the efficiency that is our unit is working the effluent treatment plants are working. So, they actually help us in many things, they also help in identifying the present and future problems of water pollution, okay. So, actually, many times when we perform this water quality monitoring for round the clock around the year, then we can understand okay, there is a seasonal variation in these water quality parameters.

And also there is a likelihood that maybe after 10 years, these are the future problems which may happen. So, they help in all these aspects. Also, they help in identifying the present resources of water as per various usages. And within our industrial premises, we can determine that where which quality of water is to be used, and after usage which quality of water is getting discharged.

So, they help in developing plants, setting priorities of water quality management program, so that we can meet the water requirements whichever may be there in future. Also, they help in evaluating the effectiveness of the present management action that we are taking. And so, they help in determining or devising the future course of actions as well.

Now, before performing the water quality monitoring or assessing the water quality, it is very essential to collect the water sample so there are many things that we should take care while collecting the water samples and water sample which are collected, they are further assessed with respect to various parameters. And these parameters may include physical parameters, chemical parameters, as well as biological parameters.

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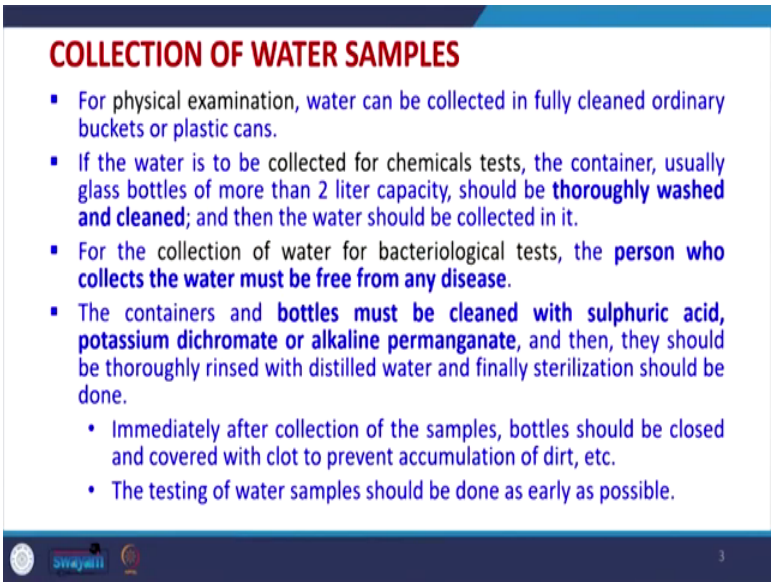

Now, depending upon that which parameters we have to determine further the collection of water has to be understood well, and during the collection, we have to take certain precautions. For physical examination only suppose, water has to be collected only for physical examination, then we can only clean the ordinary buckets or plastic cans and collect the water in them and then we can go for evaluating the physical parameters.

If the water is to be collected for chemical tests etc., then the container should be a container which may be a glass bottle. And generally, the glass, these glass bottles are more than two liter capacity, because we have to perform a large number of tests. So, we require enough water quantity so that we can perform all the tests.

So, these glass bottles are more than two liter capacity are thoroughly washed and cleaned and then rinsed back and then the water is collected. So, this is very essential that we should thoroughly wash them, rinse them and further clean them before collecting the water. If the water

is to be collected for bacteriological tests, it is possible that we had to collect the water and we have to perform a lot of bacteriological tests on the collected water.

Then the person who is collecting the water must be free from any disease that is very essential. And also, we have to clean the water bottle with sulfuric acid, potassium dichromate or some alkaline permanganate and then they should be thoroughly rinsed with distilled water and finally sterilized before collecting the water in them.

And if possible, after collection, the bottle should be immediately closed that has to be done very quickly and the testing of the waters sample should be done as early as possible, it is very important that we test this water if we are collecting them for bacteriological test as early as possible, so that there is no further change in the water quality parameters.

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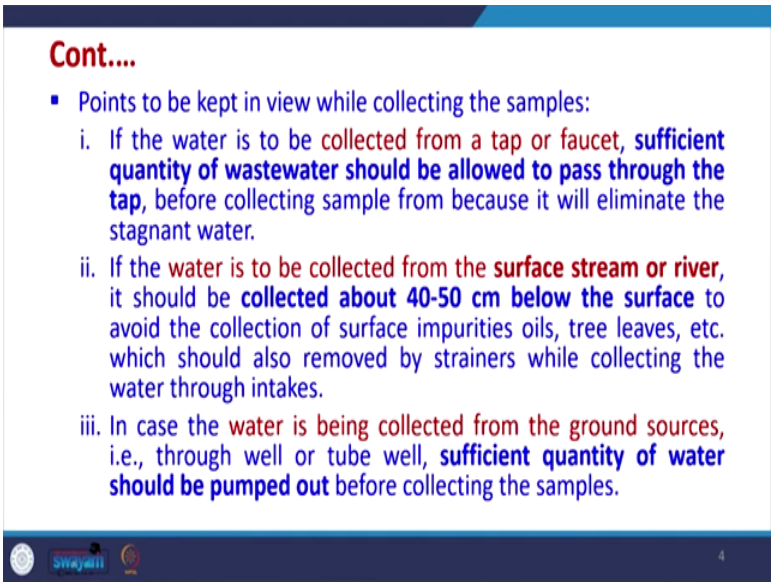

Now, while collecting the samples, there are certain other points that have to be taken care of, if water is to be collected from a tap of faucet, then sufficient quantity of water should be allowed to pass through the tap before collecting. So, we should open that tap let sufficient quantity of water pass before collecting the water for further analysis.

If the water is to be collected from surface stream or river, it should be collected about 40, 50 centimeters below the surface. This is done so as to avoid the collection of surface impurities such as oils, tree leaves, etc. And this will also help in removing other strainers while collecting the water through the these intakes.

Also, if the water is to be collected from the ground sources and for doing this generally we may use wells or tube wells, so sufficient quantity of water should be pumped out before collecting the sample. These are essential precautions that have to be taken care before collecting the water sample for further testing.

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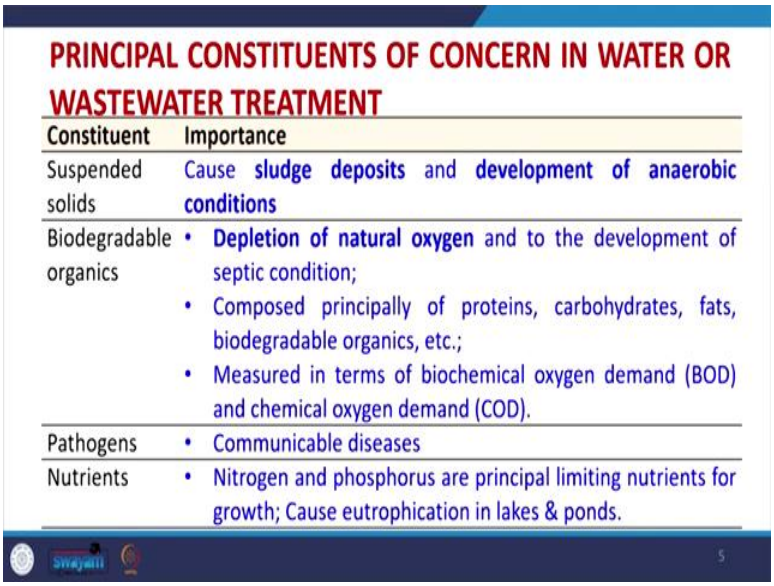

Now, there are some principal constituents in water which are our major concern during water or wastewater treatment, and some of them are listed here. Certainly, we are going to further discuss them in detail. So, one of them is like suspended solids and they cause a lot of sludge deposits and development of anaerobic conditions and various other problems.

So suspended solids is one of the principal constituent. Then any biodegradable organic and so, these are very, very important for any wastewater treatment. So, these biodegradable organics, if they are present in water, they will cause depletion of natural oxygen because they will automatically degrade if they are present in the water and they will use the natural oxygen which is available in the water.

So, they if there is no further supply of oxygen from any other place, then there may be a development of septic condition within that water itself. Also, these biodegradable organics are generally composed of proteins, carbohydrate, fats, biodegrade, other biodegradable organics, etc and they are generally metered in terms of biochemical oxygen demand and chemical oxygen demand, we will discuss these two parameters in detail later on.

Then there are many pathogens which may be present generally and they may cause communicable diseases. Generally, simple water quality parameter estimation techniques do not calculate the pathogens, there is only one parameter MPN which is generally determined, otherwise the pathogens have to be tested by some other pathology and it does not falls into the category of like a common chemical engineer or a chemistry lab person can determine this pathogen.

So, we require a very special type of knowledge for determining pathogens. So, but we have some parameters which can be determined easily. Then nutrients like phosphorus and nitrogen, if they are present in water in sufficient quantity, they cause a lot of eutrophication. So, they are of primary interest in the water.

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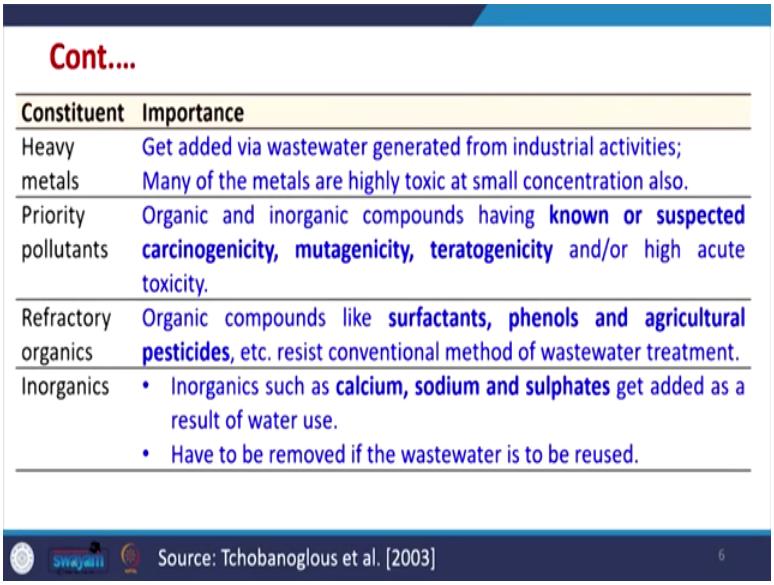

Similarly, heavy metals, a lot of heavy metals are highly toxic, and generally they are generated from industrial activities and they get discharged into the water bodies. So, analyzing these heavy metals is very, very important, even at very low concentration also.

So, we will try to understand different sophisticated instruments or titration methods generally, which will not be good enough because the standards which are there with respect to heavy metals have been highly lowered. So, that means there the maximum allowable limit with respect to heavy metals and other toxic metals is very, very low.

And generally, they cannot be determined up to those limits by Titration method. So, nowadays of sophisticated instruments are used for determining the concentration of heavy metals in the water. Similarly, some priority pollutants may also come out, which may be organic and inorganic compounds, and which may have suspected carcinogenicity, mutagenicity and teratogenicity. And they are highly toxic and therefore, their determination is very essential.

So, for them also highly sophisticated instruments are used, refractory organics if they are present refractory organics are those things which cannot be degraded in the conventional wastewater treatment method, including the biological wastewater treatment approaches.

So, and these may include like surfactant, phenols, agricultural pesticides, etc., and they have aromatic ring structures or they are very difficult to degrade, and they are toxic to biological microorganisms as well. So, they cannot be treated as such in the conventional wastewater treatment.

So, they are of primary interest to during the wastewater treatment and during parameter estimation as well. Then similarly, inorganics, such as calcium hydrogen sulfate, etc. get added, because of the water use, and they have to be removed before the water can be reused. So, they also need to be determined.

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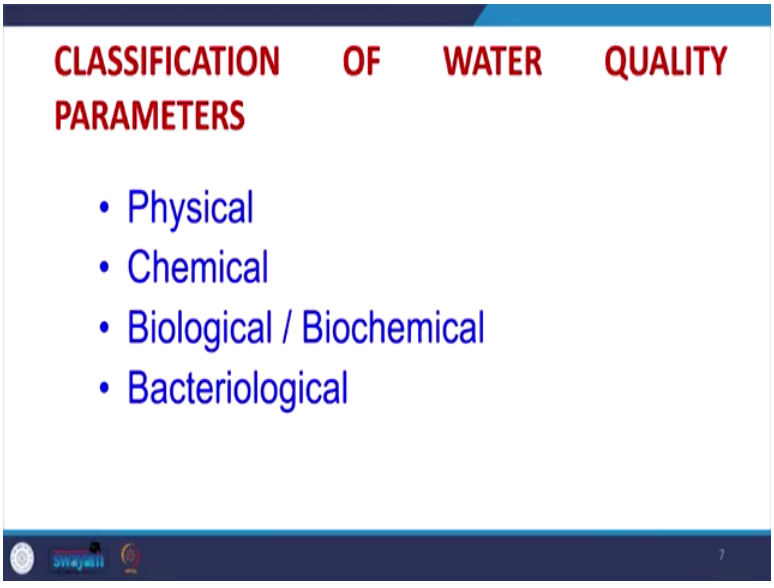

Now, water quality parameters are classified into four categories, and we will also be studying in the same order in detail. So, they are like physical, chemical, biological or biochemical and then

bacteriological as already told bacteriological will be out of the scope of us as it is very difficult to determine the bacteriological parameters as such in the water and specialist like in the pathologists are required for determining these parameters, but physical, chemical and biological parameters which are common can be determined by a simple water chemist.

And we can, we should understand all these parameters in detail. So, and we will start with the physical parameters today itself and try to understand some of the physical parameters that are essential to be determined for assessing the water quality. Now, one of the first parameters and easiest parameter is determining the temperature of water.

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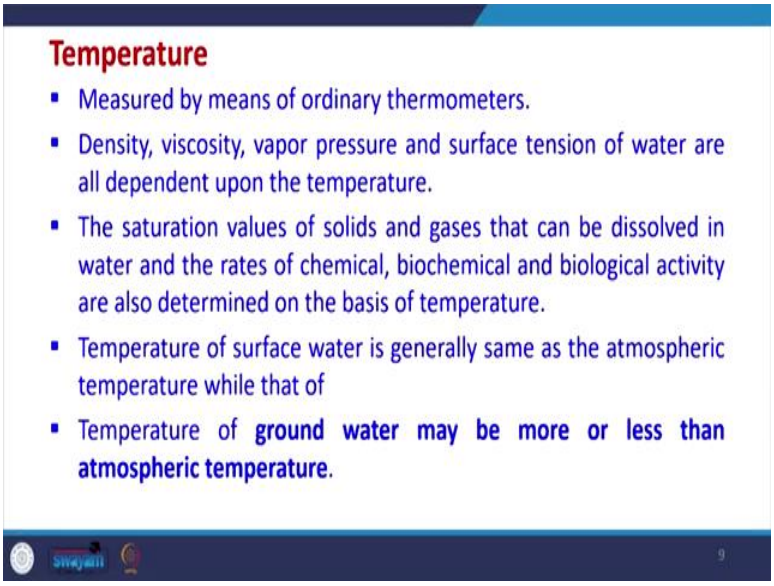

So, it is very easy and it can be determined by ordinary thermometers because the water temperature does not varies that much and ordinary thermometers can be used for determining the temperature. Now, the question can be that why temperature, temperature does not have that much any of the water quality.

So, the reason behind is that the density, viscosity, vapor pressure, surface tension of water all are dependent upon temperature, there is another parameter which is highly dependent upon temperature and it is the solubility of gases. So, and these gases have different solubility at different temperatures and for gases in particular and including oxygen, the solubility decreases with increase in temperature. So, that means, if we drink a normal water.

So, it will be having more amount of oxygen, however, if that water is further heated to maybe by 10 degree we can easily find that water has lesser quantity of oxygen and will feel the same. Similarly, if a high temperature water is suddenly discharged to any aquatic body, then the aquatic animals that are present or aquatic fishes, etc., which are present in that water body maybe river, those will be having suddenly lower oxygen.

So, then they may have lot of problems with respect to high temperature water. So, that is why it is very essential to maintain a certain temperature and government of India as per their standards have also mandated not to discharge water at much higher temperature and in particular, this is true for this thermal power plants because they take water from any canal or river and further use it for generation of steam.

And though they reuse that water a lot many times but still they require some amount of additional water each time and also they have to discharge some water back. So, there is a guideline that this can never discharge any water more than 10 degree increase in temperature. So, that means if they are taking the water at 20 degrees centigrade, they cannot discharge the water beyond 30 degree to the same lake or river or the canal. So, this is very essential.

So, temperature because of the solubility of gases and in particular for because of solubility of oxygen which decreases with the increase in temperature, temperature becomes very essential parameters. So, temperature of the, also the temperature of surface water is generally if you have to measure like temperature, so the temperature of surface water will generally be same as the atmospheric temperature, while that of temperature of groundwater maybe more or less than the atmospheric temperature.

So, it will depend upon the season in which we are measuring the temperature of groundwater. So, it depends upon the different seasons, but for the surface water generally it is same as the atmospheric temperature.

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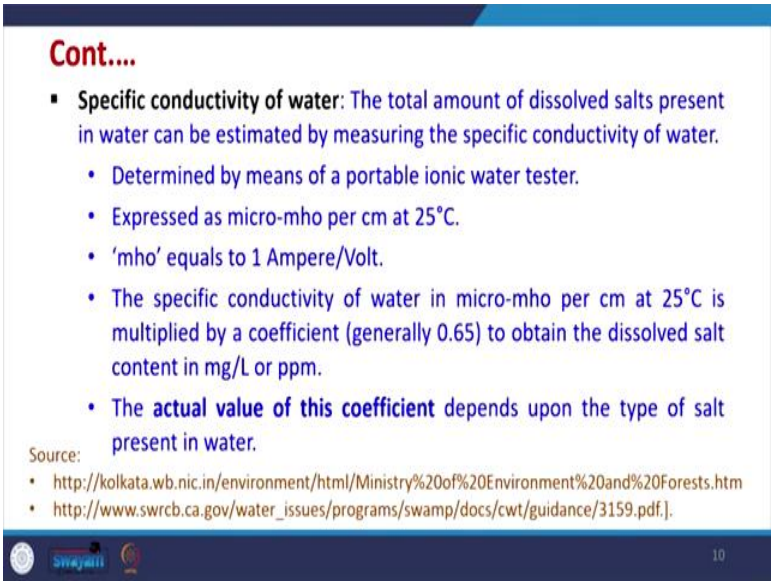

Now, the second parameter is specific conductivity of the water. The specific conductivity of water actually, it is a parameter which gives idea about what is the total amount of dissolved salts present in the water. And this we can determine by determining the specific conductivity of water.

And specific conductivity can be determined by means of simple portable ionic water tests which are available and generally the specific conductivity is expressed as micro 'mho' per centimeter at 25 degrees centigrade. And for just knowledge 'mho' is equal to 1 ampere per volt. So, the specific conductivity of water in micro mho per centimeter at 25 degrees centigrade, if it is multiplied by some coefficient.

And generally, this coefficient may be in the range of 0.5 to 0.65, 0.7 And if we multiply by that we can get that dissolved salt concentration in milligram per liter. So, by just measuring the specific conductivity we can get that TDS that total dissolved salt concentration, the actual value of this coefficient may vary depending upon the type of salt present in the water.

Now, there is third important parameter it is called as color. So, the color of water maybe because of various reasons, it may be due to the presence of organic matter in colloidal condition.

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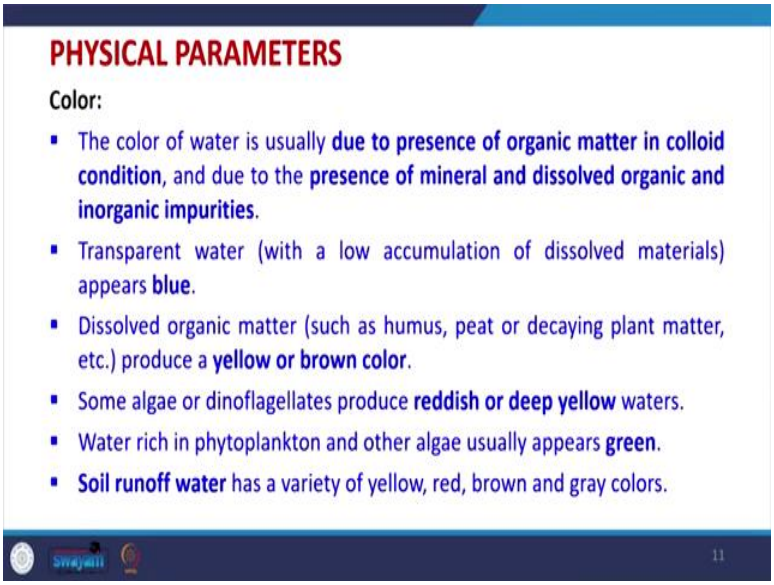

So, if any organic matter is there, and if it is in the form of collides, it will impart color to the water also various minerals, dissolved organic and inorganic impurities present in the water impart color to them. Transparent water with a very small amount of dissolved materials will appear to be blue.

However, if dissolved organic matter which may be humus, peat or decaying plant matter, they produce yellow or brown color. So, this is there. Then some algae they produce reddish or deep yellow water. So, they are different types of, from the looking at the water, how which color we can have a tentative idea also, water rich in phytoplankton and other algae as they appear green in color. So, this is there.

Soil runoff water which is like a water which is collected after ending of a variety of soil may have a variety of color also a yellow, red, brown, gray color, etc. So, the color of the water may vary and it depends upon the which type of minerals or organics or inorganics have been dissolved in that water.

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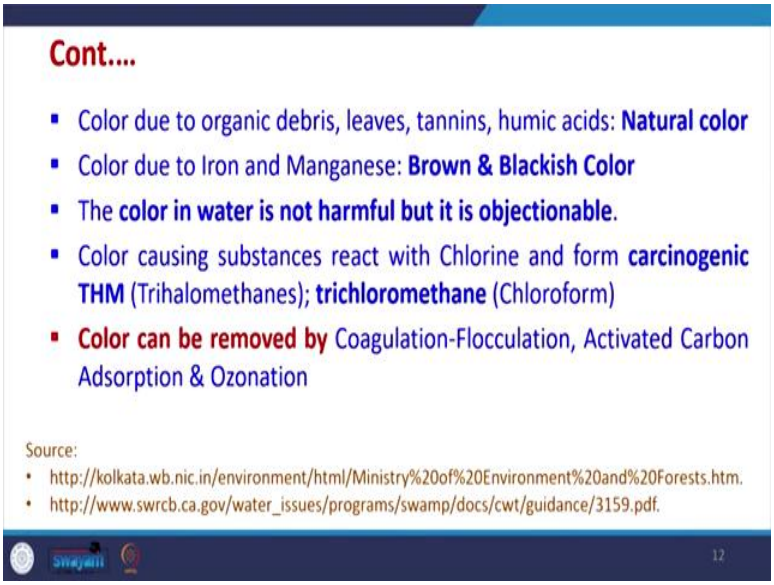

Now, color due to organic debris, leaves, tannins, humic acids, they are generally called as natural color because they are always present. So, this is like natural color, color due to iron and manganese will be brown and blackish in nature. And as such, if color any water is having color, it is not harmful until unless the dissolve impurity itself is harmful.

So, color as such is not harmful. But if color causing substances during water treatment, it has been found that we add lot of chlorine for disinfection. Now, these color causing substances if they are present like humus and other things, if they are react with the chlorine, so it may form lot of carcinogenic compounds using trihalomethanes, chloroform etc.

So, this type of things have come recently in the studies, so, we have to see that these formation of these things can be avoided. So, amount of chlorine either has to be reduced or the color has to be reduced before adding the chlorine. So, color can be reduced by a number of methods using coagulation-flocculation, activated carbon, adsorption ozonation, etc. that we will study later on.

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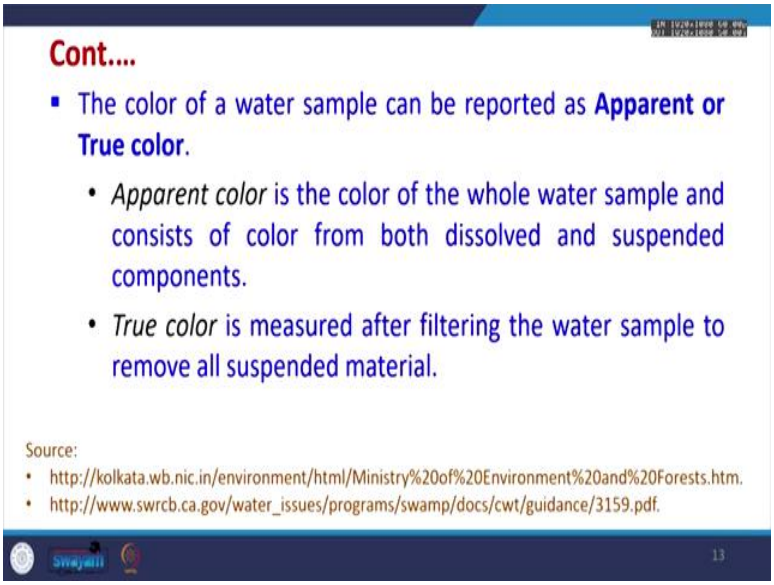

The color in the water sample can be reported as apparent or true. What is the difference between apparent color and true color, apparent color is the color of the whole water sample and consists of both dissolved color due to both dissolved and suspended components.

But if we can remove the suspended components, because they can be removed very easily, then by filtration or otherwise, then the color of the water sample after removing all the suspended material is called true color. So, true color is actually a better item to be removed to be deported and we should remove the suspended materials before determining the color.

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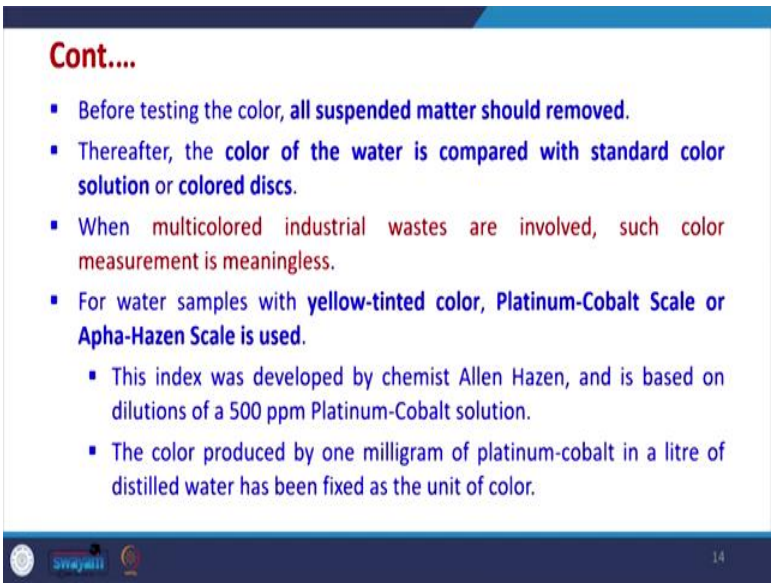

Now, so, before testing the color all suspended matter should be removed. Thereafter the color of the water generally can be compared with standard color solutions which are available or color disc and we can from that we can report okay the color of water is this, okay. Then a lot of industrial wastes have lot, their water is multicolored and such color report or measurement is meaningless. So, it is very difficult to report color of such water.

Now, for water sample which are having yellow tinted color, okay so which are yellowish in nature, there was a one method which was developed by Hezen. And that method is scale is called platinum cobalt scale or Alpha-Hazen scale. In this method actually, which was developed by Allen Hazen it is based upon the dilution of 500 ppm platinum cobalt solution and whichever color after different dilution whichever color is obtained that is reported.

The color produced by one milligram of platinum cobalt in a liter of distilled water has been fixed as the unit of the color. So, this is the basic and then they may have different units. So, based upon that, the platinum cobalt unit may be reported. But this is true only for yellow tinted color, it is not true for any other type of color.

So, how to determine the color this is very very important and maybe we do not report the color, but for many wastewaters it is essential to measure the color removal efficiency of the units which are actually testing the, treating that water. So, how to determine the color removal efficiency of various units?

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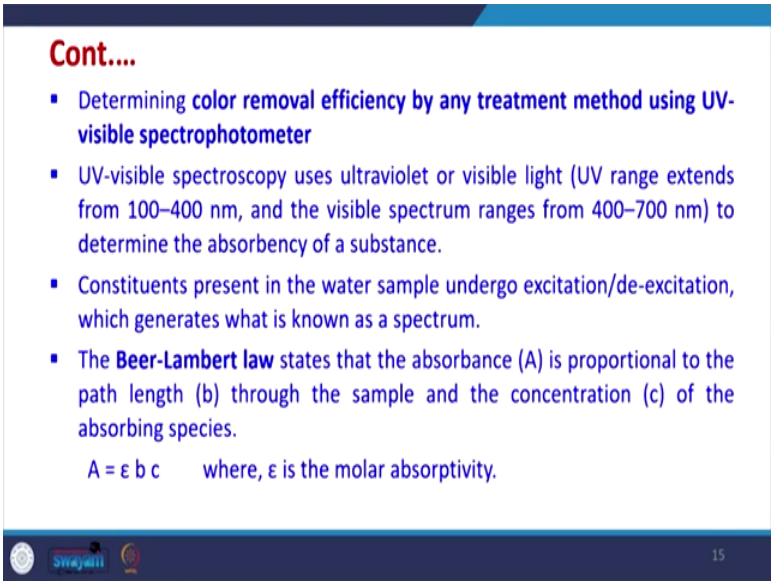

So, this can be determined and this is determined by using UV visible spectrophotometer. The UV visible spectroscopy actually uses ultraviolet or visible light and which actually the range varies from 100 to 700 nanometers out of this the visible spectrum range is 400 to 700 nanometer and the UV range is from 100 to 400 nanometer.

In fact, this UV visible spectrophotometer can be used for determining the concentration of lot of organic compounds also. Now, constituents in the, present in the water sample when a particular light is thrown on that then that sample undergoes excitation or de-excitation and this generates a spectrum and that is spectra is noted down and from that we report the color removal efficiency.

Now, using during determination of color removal efficiency what we do is that we use the Beer-Lambert law and as per that the absorbance of light of particular wavelength by that water which is present in that water sample it is proportional to the path length through the sample. So, that means, suppose we are using any cylindrical or any rectangular type of cuboid type of thing.

So, in that whatever is the path length, the absorbance will depend upon that and also the concentration of absorbing species. So, if suppose the absorbance is A and the path length is b and the concentration of the absorbing species present in the water sample is c. So, A is directly proportional to product of b and c and the proportionality constant is called the molar absorptivity. So, we use this Beer-Lambert law for determining the color removal efficiencies. So, how do we do that?

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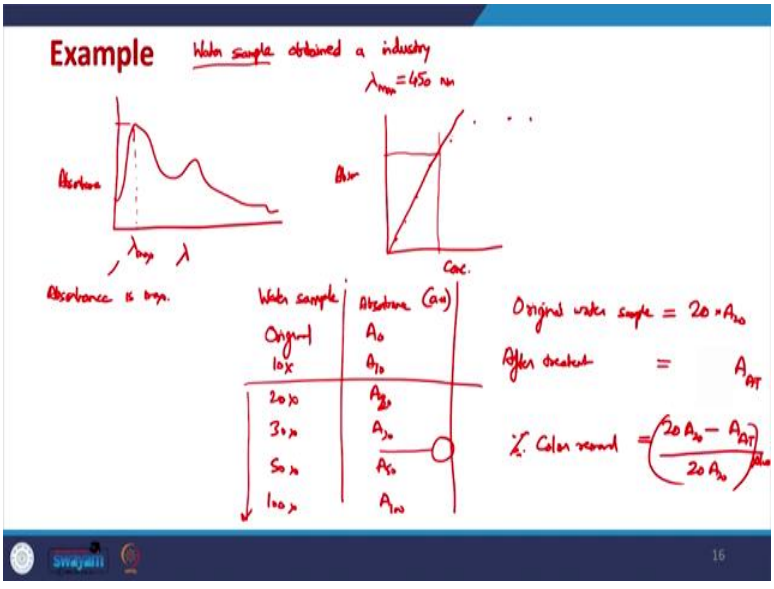

So, suppose any water sample is obtained from any industry, so, we have a water sample which is obtained from a industry water sample obtained from a industry. Now, after getting this water what we do is that we take the sample put it in the UV visible spectrophotometer and we try to determine that at what lambda value it has absorbance, so, we try to determine this type of graph and this may vary like this, okay. So, this is there.

So, what we do is that we try to see that which is the lambda at which it is having a maximum value of absorbance. So, this particular lambda is called lambda max. So, if we choose a lambda max value actually it helps in lowering the lower detection limit of the color. So, that is why we choose this lambda max, the absorbance is maximum at this lambda.

So, that is why it is called lambda max this is not maximum lambda, the absorbance is maximum for this particular lambda. So, this is why it is called the lambda max. So, now, in the next step what is done is that, that we choose this lambda max suppose, it is 450 nanometer I am just arbitrarily choosing. So, after that what we do is that we try to find out dilute this water sample.

So, this water sample which is there, we dilute it a number of times, so, maybe original sample and then different dilutions. So, diluted sample maybe 10x dilution, 20x, 30x, 50x, 100x. So, through that we try to determine the absorbance at all these values. So, we try to see that what is the absorbance value which will be in arbitrary unit.

So, this will be a.u. arbitrary unit and we can find out the value of lambda and what we do is that, since this is the highest dilution, so, we can assume the concentration if we just assume this to be original concentration, so, it will be 100 times less concentration. So, concentration will be lowest here. So, we find out the value I am just booting the absorbance as A100, A50, A30 like that for our easy understanding and through this Ao, so this type of graph may come.

So, and this is the absorbance. So, from this we come to know okay this type of graph, so, we use the graph which is in the linear range, we generally avoid the graph which is saturated, so, this up till this point only this graph can be used.

So, what we do is that, so, that means, we understand it is possible that the this is linear only after 20 times dilution, so, that means the original absorbance, absorbance of original water sample, so, original water sample original water sample is having a absorbance of if we assume A20 so, and it is diluted 20 times so, we can consider it to be 20 times A20.

Now, after treatment what we do that after treatment, we again determine that absorbance at this lambda max, okay. So, after treatment, suppose the value comes out to be in between some value. So, suppose it is here. So, this value will be known to us. So, A after statement I am writing AT, so, then what is the percent color removal efficiency. So, we can easily determine the percent color removal efficiency as original sample whatever is the value.

So, that will be 20 A20 minus A AT after treatment divided by 20 into A20 into 100. So, this is the method through which we can determine the color removal efficiency of any water sample, any unit in any water sample before and after treatment. So, this way we can understand the color removal efficiency, and this is how it is reported in the research papers and other places. So, now we end the today's lecture and we will continue these parameters in the next lecture. So, thank you all for today. Thank you.