Wastewater Treatment and Recycling
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Lecture – 11
Waste water characteristics: Quality Parameters

Hello friends. So, welcome to the third week of the course and previous week, we started discussing about the quantitative estimation of the waste water and this week, we will focus on the quality of the waste water. So, how the waste water is characterized, how we certain waste water is very bad or bad or poor or ok or how we basically qualitatively characterize a certain type of water or say waste water.

So, for the purpose, we all understand that just by looking at the water, it is very difficult to tell how contaminated is that how polluted is, there are a variety of continents or there is several type of pollution which does not impart any physical attributes. So, it will be very difficult to see if you have a let us say water bottle and I dissolve certain amount of salt in it probably, by seeing it, you will not be able to tell it or that way, if I dissolve certain say metal or colour less metal or salt or organic contaminants just by seeing it by touching it, it is very difficult to tell.

So, since just the physical appearance of the water may not be sufficient to characterize it or may not be sufficient to distinguish about its quality, it becomes essential to sort of fix a certain set of parameters based on which the water or waste water could be characterized. So, we will discuss these parameters one by one in this week.

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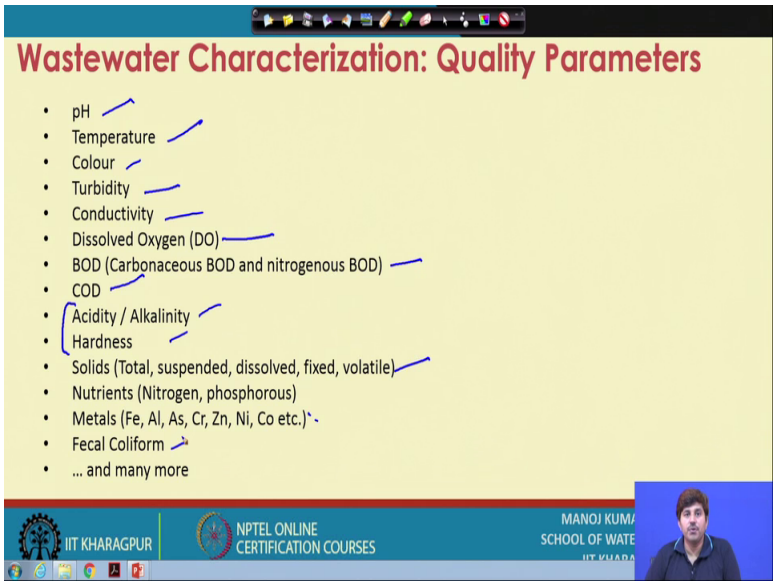

To begin with there are variety of quality parameters ok, there are certain physical parameters, chemical parameters, biological parameters. So, we can club them into the different classes as well possibly and otherwise, if you like see a list. So, there are several parameters based on which the quality of certain water or waste water could be characterized; the list is not limited because we are having emerging contaminants.

So, that way, we are we can add more and more parameters for characterizing, there are certain things which earlier was not considered as a let us say contaminant or a pollutant, but nowadays those are being perceived as a contaminant. So, for ascertaining a good quality of water or ascertaining a treated reusable quality of waste water we need to check those parameters as well and that way, it becomes sort of endless list of the quality parameters.

We will discuss certain more prominent or more important or more common parameters which are typically used for assigning the quality or characterizing the particularly specific type of water or waste water ok. There are few very popular or well known stuffs like we have pH, temperature, colour everyone almost knows it ok, what pH is, what temperature is, what colour is, then there could be the turbidity, there could be conductivity, the level of dissolved oxygen in it, then the biological oxygen demand or few people say, it biochemical oxygen demand. So, that is typically known as BOD. It is a carbonaceous BOD or nitrogenous BOD means it is out of carbonic organic

compounds or out of nitrogenous compounds then chemical oxygen demand that is COD, there is a acidity alkalinity hardness, these are not that relevant for waste water though more relevant for water quality.

There are varieties of solids the total solids suspended solids dissolved solids fixed or volatile solids. So, a range of these such parameters there are nutrients the more common one are nitrogen and phosphorus there are metals again an endless list of metals iron aluminium arsenic chromium zinc nickel cobalt silver lead. So, there are many more and. So, there are then some biological impurities. So, fecal coliform or those kind of stuff, particularly, we can go more in more details in the form of bacteria protozoa virus what kind of biological impurities the water has.

And again, there are quite a lot more which these days, we have the pharmaceuticals, we have the disinfection by products we have the chlorinated organic compounds, we have. So, there are personal care products, pharma products, industrial pollutants, dies. So, lot more parameters are coming in. The one that we see here most of most of them are the general parameters that are the most essential or the most basic one which are typically first analysed in order to assign the or in order to characterize a certain type of water. And then there is a scope for further and further and further detail investigation if there is a need for that. So, we will see some of these parameters or the major this parameters how they affect.

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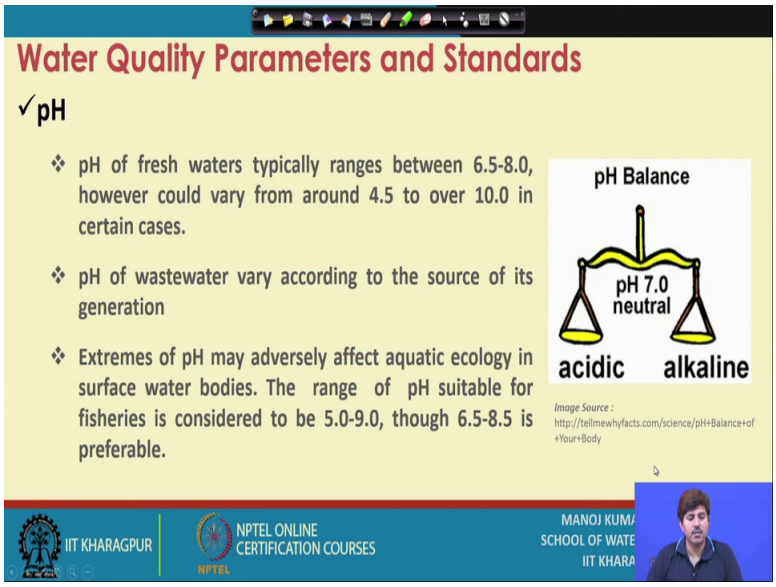

To begin with; pH is one of the most common ok. Most of the people know; what pH is ok, natural value is 7 less than that is considered acidic more than that is considered alkaline. If we talk about the water sources the natural water sources typically have a pH in ranging from 6.5 to 8 in most cases. However, in extreme cases like if it is a coming from acidic rock or those kind of things. So, it could be as low as around 4.5 or a particularly in alkaline conditions or those kind of thing where it is coming let us say from diamond those zones, it could be as high as 10 or could be over 10 also in certain cases.

For waste water, again it depends on the source of its generation ok, the different sources the domestic waste water typically does not have too high or too lower pH, it is typically in the range of again 6.5 to 8 only. However, depending on the other sources like some industrial effluents could have very low pH ok, some could have very high pH. So, again, it will vary depending on its source of the generation.

The pH is important because extreme pH may adversely affect the aquatic ecology in surface water bodies ok, we know that our aquatic ecosystems will get completely destroys if pH changes abruptly the particularly like for say fishes. So, fisheries the sort of like preferable pH range is 6.5 to 8.5, they can tolerate up to say 5 or 8, but extremely acidic or extremely alkaline pH conditions fishes is wont able to survive. So, are about the various other aquatic organisms, aquatic plants so, the importance of the pH although it is a very common parameter. But, it is very important quality parameter which gives an idea about the sort of acidic or alkaline nature of the water or say waste water.

The measurements are pretty simple there are pH electrodes which typically will give you a instantaneous pH value. So, you just insert the electrode into the water and metre will read you and tell you what is the pH, we need to calibrate it often and the calibration could be 2 point calibration or 3 point calibration depending on the range. We are looking for, if you are trying to work on acidic range, we can have a 2 point calibration between 7 and 4, if you are working on a basic range, we can have 2 point calibration between 7 and 11 or 9, if we are working on a wider range, we can have a 3 point calibration 7; 4 and 9 or 11 that way.

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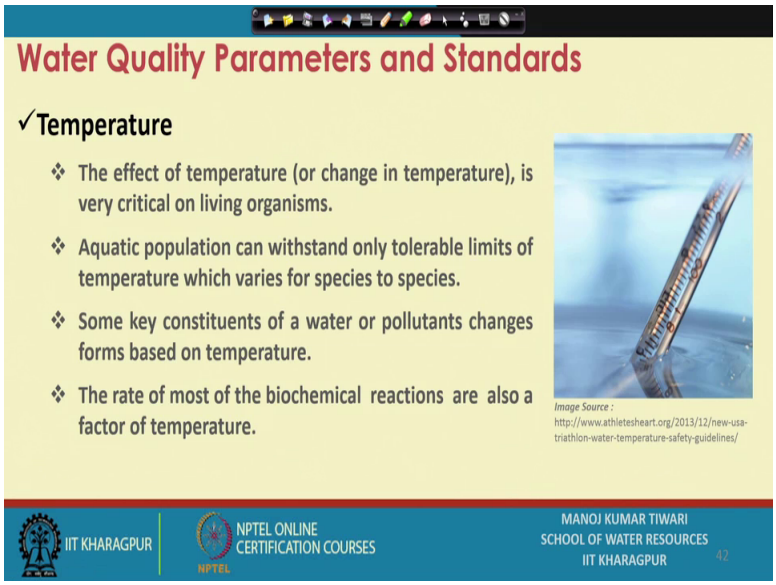

The other parameter is temperature. So, a temperature is again a pretty easy to measure and monitor, but have very severe effects ok. We have simple thermometers which can or this kind of monitors which can basically just tell the value, tell the temperature and there are 3 different scales Kelvin, Fahrenheit and Celsius. So, there is possibility of interchanging between this case, these are the common stuff that everyone knows though.

The effect of temperature or more particularly the change in temperature is very critical in living organisms ok, like for our body, we know that we can survive only till a certain range of temperature for purpose of drinking water. We can we cannot drink let us say water which is boiling it is very difficult to drink that water, it is going to do a lot of damage in our internal abdominal systems.

So, warm water or that kind of thing can be sort of consumed, but again, it depends not only on us for different living organisms, it could have variable effects, the aquatic population can with stand only a tolerable limit of temperature which varies for species to species. So, certain species have a higher tolerability ok, certain species cannot tolerate that higher temperature, we know that depending on the climates of the different continents. We get different kind of species proliferating in terms of not only the animal species, even the plants species as well ok, you see in the colder climates, you could have, you will have different type of trees or herbs or plants, you bring them to a warm

climate, they would not survive. Similarly, the will not warm climate plants trees herbs would not survive in the colder climate.

Same is for animals over here; animal or any other such population and even in the microorganisms ok. So, we have a mesophilic range of microorganisms or bacteria which can survive moderate temperature range of say 10-15 degree Celsius to 35-40 degree Celsius ok, optimum being around 30-35, the thermophilics, they can survive up to 70-80 degree Celsius ok, their optimum range would be 50 plus for working. So, there are different range in which the different species prefer to survive and prefer to work. There are some key constitutes of a water or pollutants present in the water which changes form based on the temperature ok, we have for say, you have ammonia man, it can actually evaporate the system, if you increase the temperature, there are volatile acids which will escape from the system.

So, the constituents of water or basically, the pollutant dissolved in it can also change the form based on the temperature to temperature, the rate of most of the biochemical reactions are also factor of temperature, this is very important for the waste water management aspect. Because, waste water management a waste water treatment, particularly when will like further lectures, we will see the treatment and sort of recycling of waste water. So, we relay lot on biochemical processes and this rate of the biochemical reactions depends on the temperature.

So, an optimum temperature maintenance is becomes essential particularly in the systems and for water also. So, if a industry is putting a let us say; there is a thermal industry and it is putting a lot of heated water into a pond or into a system into lake the entire water may get hard. So, you will not going to get the expected natural flora and fauna in that late because of the temperature issues. So, those kinds of issues and those kind of problems can arise due to the temperature. So, temperature all though very common very simple to measure very simple to monitor, but plays a very important role in the characterization of the fluid or waste water.

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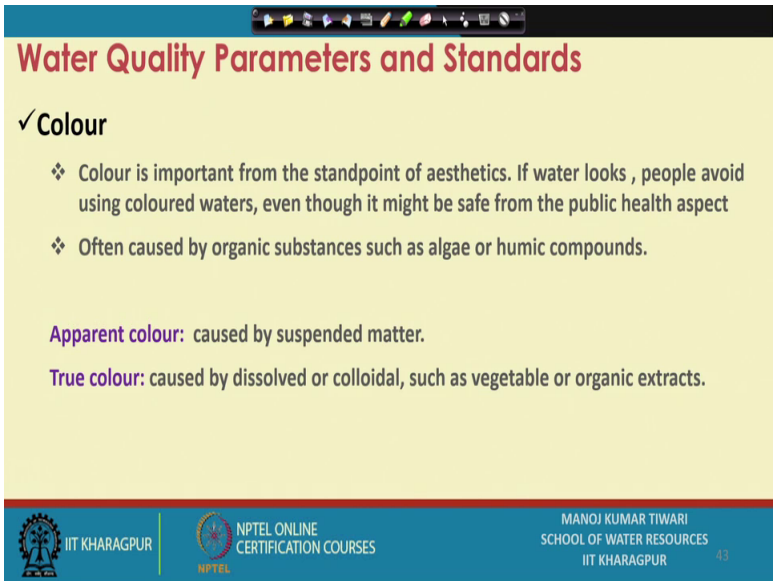

Then comes another quality parameter which is colour ok. Now colour is important from the stand point of aesthetics because if certain water looks coloured ok, people will make a perception that this water is not good a industry is let us say letting flow a coloured water people will say oh this water is very contaminated, it has something in it, right. So, colour may or may not be safe, it is not necessarily that colour is always not safe at the same point, it is not necessary that colour is always safe, it may not be safe also because colour maybe from the may arise from variety of toxic constituents as well, but may arise from simple humic substances which are not that harmful in a way.

So, a variety of organic substances; we consume lot of colour in our food. So, colour as in is not a harmful thing, but when it is in the water, if certain water is coloured and if we are offered to drink that water, we will now one is probably going to drink that water. Even though water may practically be very safe ok, if we are offered a coloured say a drink ok, we have let us say all of us or majority of us drink coke ok, it is a very black colour thing. We drink tea it is it has a certain colour, we drink lot of shakes in a variety of colours, we will have a strawberry shake will have a means some will be pink some will be purple some will be blue. So, we have a variety of shakes, cerbuths and we are very happy to drink that.

But if you ask for a water and I give you a water of let us say pink colour or water of a reddish or yellowish colour you will probably not take that for drinking purpose. So, it

may not be unsafe the colour actually may not be unsafe, but because of it is aesthetic points of view people perceive it not to be a good quality of water. So, this kind of practical problems arises.

Now, the colour are typically of 2 types. One is apparent colour and one is true colour. So, the apparent colour is caused by the suspended matters. So, something which is coloured in nature and if it is suspended in the water, your water will also look coloured, but it is not the colour of water, it is actually the colour of those particles which are suspended in the water and if we let those particles settle somehow if we remove those particles. So, if we filter that water those particles are removed or if we let that those particles settle down the bottom. So, the water is actually because water does not have any colour the colour was because of those suspended particles. So, water becomes a colourless or comes in its natural state.

So, this kind of colour are called apparent colour because it is not the colour of water itself its colour of the additional item impurity present in the water which can easily be removed. So, these are called apparent colour then there are true colours which are due to dissolve or colloidal particles ok. So, organic extracts vegetables and those kind of thing now these because they are in the dissolved state. So, even if you filter it is not going to get removed even if you let it remain for a large period of time nothing is going to settle it is already in the dissolved state.

So, the colour will remain with the water. So, that becomes the colour of although, it may be because of certain things dissolved in it, but essentially it is a colour of that solution and that is why it is called true colour. So, true colour cannot be removed simply by keeping it or simply by filtering it while apparent colour can be removed, if we tend to filter that water or if we tend to settle the suspended particles which are imparting that apparent colour to the water. So, that is what is colour.

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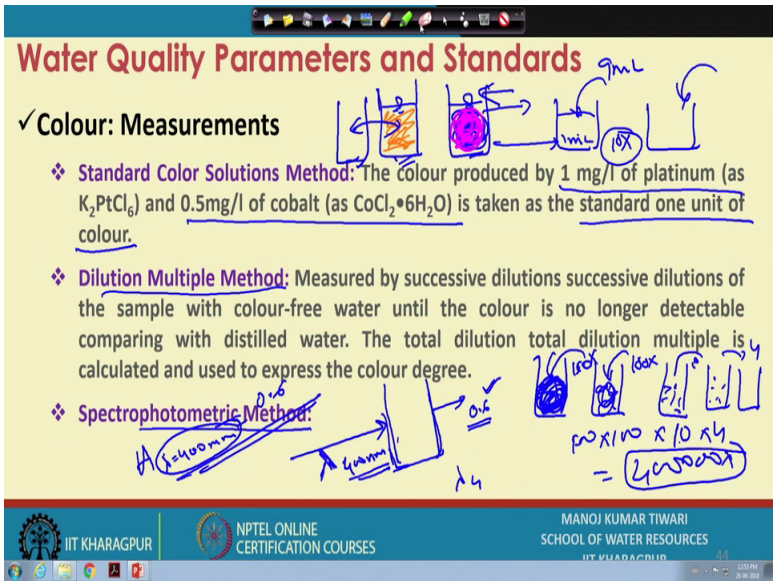

Now for quantification purpose because as we say that we earlier discuss the temperature and pH, they are fairly easy to estimate you have just meters and then we put down it will tell you the pH value between 0 to 14, you put down that your thermometer or temperature probe, it will quickly tell you; what is the temperature in what is ever unit. The colour measurement is have various or different scales. So, previously like earlier the colour was measured using the standard colour solution or dilution methods.

So, standard colours solution method is basically, we prepare a solution of a one milligram per litre of platinum and 0.5 milligram per litre of cobalt. So, these 2 are taken and dissolved in pure colourless water and that solution is taken as the standard one unit of colour. So, we have one scale prepared which is called platinum cobalt scale of colour.

So, we take that platinum salt and cobalt salt as recommended and we dissolved it what is ever colour produced out of this is called standard one unit of colour. So, that is standard colours solution preparation and then for measurement purpose we compare the. So, for say let us say; if this is my solution which is having some sort of colour in it let us say put a very light kind of colour over here.

Now, if my actual sample is having much darker colour, then this is let us say having very dark colour something or you can have let us say any colour that way. So, if my actual solution is something like this now how I measure the colour on this platinum cobalt scale is I start diluting this sample. So, I will prepare different dilutions I will take

let us say 1 m l of this and add 9 m l of water. So, 1 m l of the solution plus 9 m l of water that gives me 10 times dilution and then whatever colour is compile again compare it with it if this is still darker I will again go for another round of dilution.

So, by I will keep on diluting it until the colour becomes equal to this. So, I will keep on diluting it until the colour become equals to this and the number of dilutions gives me the sort of a unit of colour on platinum cobalt scale if I have diluted it lets say I got the exact colour after 2500 times dilution. So, I will say that the colour of the solution is 2500 times on platinum cobalt scale standard platinum cobalt scale. Similar, approach is adopted in your multiple dilution method or dilution multiple method where it is measured by the successive dilution until the solution turns completely colour free or the colour is no longer detectable comparing with the distilled water.

So, here we have a standard solution of platinum cobalt scale and we are diluting it and comparing it with that standard solution. Now here, we have it could be other way also like if the colour is less than this, we can dilute the standard cobalt solution and see it, we can bring it in the fractional form as well. So, whatever could be the range of the colour, here we have to dilute the sample steadily and progressively until it turns colourless completely.

So, if a solution; let us say which is too dark over here, we diluted it 100 times it become lesser dark we diluted it further 100 times it become very less dark, we diluted it another set and times it become very minute and we diluted it another 4 times, it becomes colourless. So, total dilution if we see 100 x into 100 into 10 into 4. So, this becomes 10,000, 100,000, 400,000. So, 400,000 dilution. So, 400,000 x is the colour based on this method that way.

However, these are the crude methods ok; the approximation techniques which were earlier used nowadays the colour is typically x measured by the by the spectrophotometric method. So, the spectrophotometers are used for measurement of colour monitoring of colour and generally, the colour value is reported as a absorbance value which are obtained through a spectrophotometer at a particular wavelength.

So, a spectrophotometer the concept is fairly simple you have a cell monochromatic light is passed through. So, let us say the value is the wavelength of this light is say for say 400 nanometre. So, if I pass this light through 400 nanometre, there would be some light

based on the how much is the colour in the solution, some light will be adsorbed there is simple photo principal. So, some light will be absorbed and based on that intensity of light incident light and intensity of absorbed light will get the certain adsorbents value.

Say if that absorbance is 0.6 for say so, then the colour will be reported as lambda that absorbance at lambda is equal to 400 nanometre is equal to 0.6. So, that is become the colour of that solution. The thing here is that this adsorbence value will depend on the wavelength. So, if we change the wavelength the adsorbence value changes. So, at which wavelength the adsorption has been taken has been recorded is of very high importance normally, if we can be spectrum of say; let us clearly tell it will then I can explain; so, if spectrum of one of the right.

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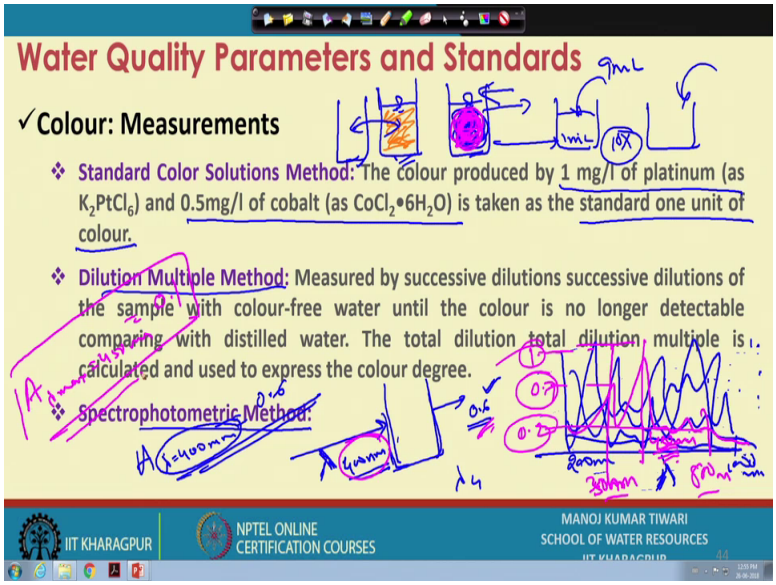

If we see the absorbance of one particular solution at different wavelength at different lambda value so, say here lambda is 200 nanometres to 1000 nanometres or 1100 nanometres. So, depending on the amount present or constraint present which is absorbing the light, we can get a absorbance spectra of let us say this type or let us say adsorption spectra of this type or an absorption spectra of this type where there is just one peak or of one of these type.

So, it could be any particular type of adsorption spectra. Now, if you see; you just pick any one of these let us say I am picking let us use one in the different colours. So, it is more prominent that way. So, let us say I got an adsorption spectra of this type. So, if for

this I take a lambda value of 350 nanometre, I get a adsorption value of say 0.7 say this is 1. So, I get an adsorption value of 0.7, if I take a say what 450 nanometre, I get adsorption value of around 1, if I say take 800 nanometres, I get an adsorption value of 0.2. So, for same solution at different wavelengths, I am getting different absorption values. So, until unless I mention this particular wavelength, it becomes very difficult to identify, it becomes very difficult to know what means later on, it will be not possible for anyone to realise at what adsorption at what wavelength this adsorption value is.

And conventionally if you want to report a colour we should choose the wavelength at which the adsorption is maximum. So, for say in this in this profile that you see here at lambda is equal to 450 nanometre as we said the adsorption is close to 1. So, we can say that the colour of this at lambda max is equal to 450 nanometre is 0.1. So, that becomes the colour of the solution or reported colour for that sample.

So, that is how the colour can be monitored and these are spectrophotometers are simple devices which works on a beer Lambert law principle, we will discuss more detail of this maybe on a later class or later session. So, for now this is how typically the colour can be monitored. So, we will end this session here and we will continue discussing rest of the water quality parameters in next session.

Thank you.