Water and Waste Water Treatment
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Lecture - 32
Water Quality Parameters

Hello everyone, welcome back to the latest lecture session. Quick recap of what we discussed in the previous session. In the previous session, we were looking at how much water to supply? And until what period are we going to supply the water? And , in this session, we are going to take it to its natural conclusion; we are going to look at what is the kind of water that we are going to supply.

For example, in the context of wastewater, we were discussing the BOD, COD and relevant parameters when we are trying to understand the strength or the quality of wastewater. But , we will not be using the same parameters when we are talking about water quality. So, let us look at these aspects or water quality relevant standards.

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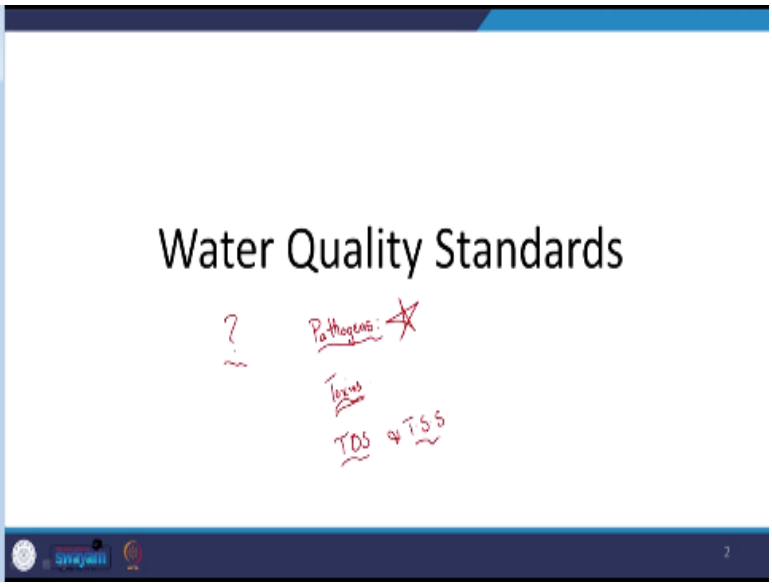

Before that just an overview, what am I typically concerned with? I am concerned with seeking that there is little to no disease transmission or pathogen transmission. So, I am almost, always concerned about pathogens. I am concerned about pathogens. So, this is the most important aspect to keep in mind. There might be if I am using groundwater, there might be deposits or contamination of groundwater due to various sources.

So, maybe then I need to look at a particular treatment mechanism for that particular kind of toxic compound. But in this course, we are going to look at the general aspects. So, after the pathogens, we will look at toxins or such, but typically lead to the rare cases. So, we will not go into that now. Another aspect that we typically almost always considered is total dissolved solids and total suspended solids.

So, these are indirect indicators. So, that is the relevant issue as total dissolved and total suspended solids, the sum will be equal to the total solids . Total suspended solids will give me an idea about pathogens and quality of water, but it is not a direct correlation, but it will give me a pretty good idea and dissolved solids will give me an idea about how much or how many ions or such, they are in that particular water, too high difficult; too low not fit for consumption.

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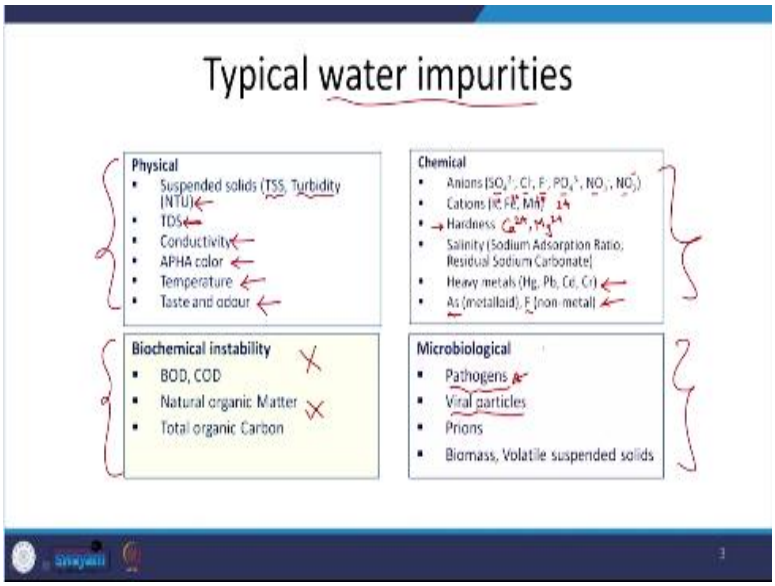

Let us move on and look at the relevant aspects. So, typically, when we talk about water impurities, we look at physical parameters to be able to estimate this water or water impurities and then chemical and biochemical and then microbiological parameters. In the context of waste water, we looked at these, but in the context of water or drinking water, we will not look at this. We will not look at this.

What do we typically look at? We look at the physical, chemical and microbiological parameters. So, as total suspended solids, we looked at that how do we measure that that is using the turbidity metre and the units are NTU. TDS, total dissolved solids, yes and we can measure that by conductivity or by direct measurement. We look at the colour of the water,

temperature too, for taste and odour, there are some tests but in India typically if it is not objectionable that is good enough for us.

When we talk about chemicals, we look at the usual cations and ions. Here, an ions, , negatively charged that will add higher concentrations, , lead as to have, , some diarrheal issues or digestive issues or such or maybe pain in the joints . So, we have those some cations, , if Fe^{2+}, Mn^{2+}, cations positively charged.

And then hardness because if the water is too hard meaning I have too higher concentration of calcium or magnesium, the bi-valent cations, that will, , not let my surfactant or soap form the relevant lather. And I will have issues whenever I am trying to clean my utensils or clean myself or clothes. And also, it can lead to scaling of the relevant pipes or utensil sensors so, that is an issue.

And heavy metals which can lead to toxicity , arsenic and fluorosis too due to fluoride , but we are not going into detail now though. Microbiological, so, we have pathogens and typically viral particles, but viruses in general come under the category of pathogens, . So, typically we are concerned with microbiological parameters too. So, let us look at where I can get this data.

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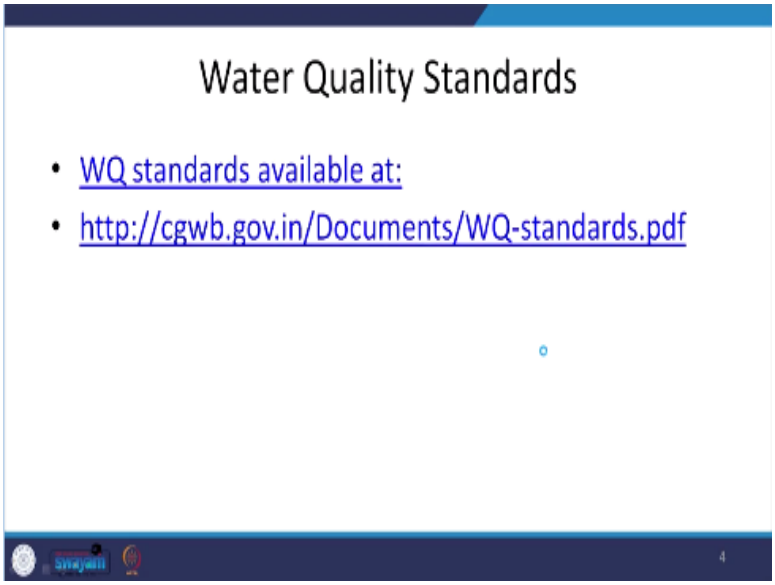

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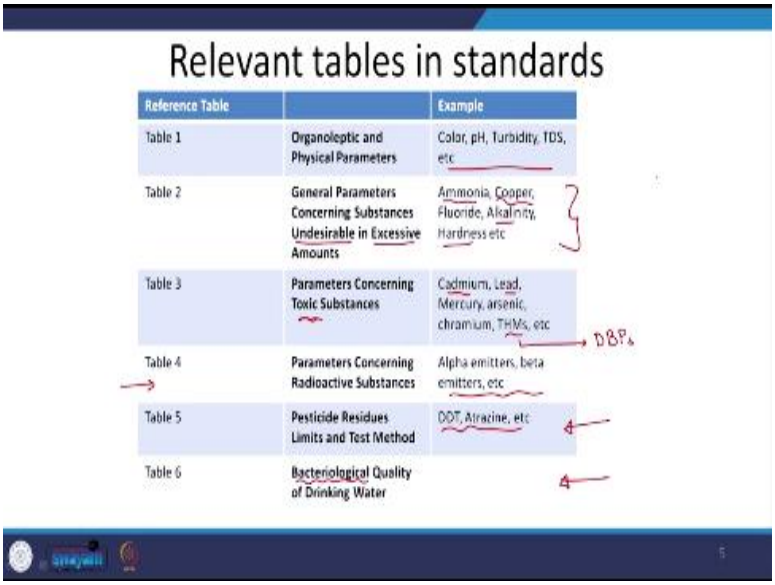

So, there are different sources. One is this particular link that you can copy paste and look at. So, relevant tables in standards where I am going to look at the standard, but let us look at the general classifications or categorization. So, first one is organoleptic and physical parameters. So, the general parameters which we discuss, which we measure when we talk about water or water quality.

Then the parameters which when excessive, you will have undesirable effects. But , copper will also have toxicity so that will come there and also in toxic substances. Typically, I am concerned about hardness alkalinity, ammonia, iron and so forth. Table 3 about toxic substances, heavy metals, typically cadmium, lead, trihalomethanes, which are the disinfection by-products we already discussed and so forth.

And radioactive substances, but rarely do we measure this in drinking water because, for example, I know, I think, they is a student group here in IIT Roorkee, one of Nav Bharat Abhiyan, they were trying to look at the water quality of a particular village or the water from the quality of the groundwater that is being consumed by villages nearby. So, they say, Banu, get the test done there, I say, for what parameters.

So, then , they are not sure, because, as you see, when we say get the test done, there are quite a few parameters , we will look at the table. So, if they are looking for a specific adverse effect, we can try to , understand the cause and then look for those, if not, the usual water quality test will not be exhaustive, it will look at only a few aspects or such. So, that is something to keep in mind.

And , as I mentioned, rarely do we look at radioactive substances, but if there are, , relevant side effects or such maybe then we will have to look at the radioactive substances. And , similarly, DDT and Atrazine if , you suspect contamination, or you see issues with respect to fertility or lack of fertility or increase in infertility levels or decrease in fertility levels, typically, that is due to pesticides.

And you have different neurological issues too due to pesticide consumption, even in low concentrations over time, then we will look at it. But if you say, hey man, get the water quality test done, , at the usual price of 3000 rupees or so, per sample, I cannot or one cannot measure all the samples that is something to keep in mind. But , we will always measure or tried to understand the bacteriological quality of drinking water.

All this will typically have long term issues I keep drinking this water over a period of time, unless the concentration is so high, due to , some accident or spill, radioactive, substance or arsenic came into the picture at very high concentrations, then I might have acute or short term effects. But in general, I will always have what we say or I am always concerned with these bacteriological effects, because they will always have, almost always have immediate effect.

And as we know, death due to diarrhoea is one of the major cause of death among the infant and the more susceptible population, which is the children. So, that is something we need to be remarkably concerned about in India.

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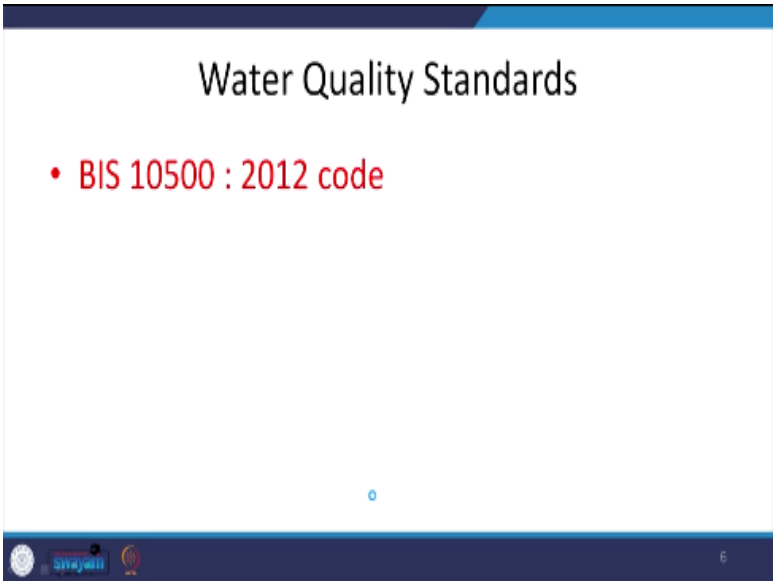

So, let us look at the relevant code BIS 10500: 2012 code . **(Video Starts: 08:40)** So, what do we have here? The second revision all this is fine. Drinking water source, this is Bureau of Indian standards, . Bureau of Indian standards. And we already looked at the link earlier, this is the revision. So, from time to time, they revise and update based on the best available practices and technology and needs too.

Keep in mind that they also looked at the EU directives, US EPA, United States Environmental Protection Agency standards for drinking water, WHO guidelines . So, it is more or less based on what we observe in India and also what the other developed countries are doing or have done, they typically have more stringent standards, but we cannot aim to achieve those standards away, but it is a step towards those standards, . Yes and World Health Organisation guidelines.

So, drinking water, as you mentioned, different kinds of parameters. The first one, the generic parameters, so pH 6.5 to 8.5, taste agreeable but no specific test. Turbidity pretty much important we have to measure this one and certainly less than 5. Total dissolved solids 500 and 2000. One aspect I would like to mention here. So, quite a few people now in India have these household water purification devices, different companies Aqua life, Aqua Pure, Water guards one and so forth.

Everybody typically tries to sell you this RO unit. The RO will have or , the effluent from RO will have very little dissolved solids, not 0 but maybe 10 or maybe 20 depending on how well it is working or such. And here, the issue is that if I drink water that has only 10 or 20,

dissolved solids that is not at all good for my health and even has effects on the cardiovascular system and digestive system too.

, I need all these ions, fluoride, calcium, magnesium in little quantities, my body needs that. Without it , I will have, , issues, different issues over the time. So just saying that RO and get that done, , as a solution for everything that misnomer if I may say so. So that is something to keep in mind. In general, the required or acceptable limit is 500.

But 300 or 350 is what is fine or 300 milligram per litre above that you will start to feel some discomfort depending on where you have been living and how long you have been, what we say, consuming that water. For example, typically people will say RO, but what is the, , the person coming to your home to install that RO unit, he will ask, what is the TDS that you want. So, you can say 300.

So, that is one way but he does not set the setting says that the water through the RO unit will come to 300. What he would do is, he will bypass some water so, that some of the water will not go through the RO unit and mix some of the water coming through the RO unit, so, that the final of these 2 streams will be around 300. , we will look at these aspects later. So, organoleptic and physical parameters and then the general parameters concerning substances which are undesirable in excessive amount.

This is something we looked at earlier. And one other aspect, I would like to mention is that we also have the kind of test as if and when there is, what we say, doubt or confusion regarding the authenticity of the tests or quality of tests. So, you have the relevant method and the reference that is given out to you. So, as you see here, aluminium, ammonia, barium, boron, but rarely would you see boron in typical waters, chloramines rarely.

But if you have a waste water that is been chlorinating there, , effluent and you are drawing water from near that particular discharge point, , chloramines will be a factor. Chloride, yes, you will have it. So, that is why the acceptable limit is given as 250 milligrams per litre, as you see it is pretty high. It is not pretty, , it is not toxic or undesirable even at relatively high concentrations.

And then you can see the relevant standard. So, nitrates, this is something that we mentioned or discussed in the context of our waste water that high nitrates are not good for, what we say, drinking water especially for or in the context of the infants, they will or their ability to transport, , oxygenated blood to different parts of the body will be remarkably affected. This is something we discussed earlier. And that is what I want to point out here, .

So, calcium, hardness and saturate 200 and so forth. Then we will move on to the toxic substances, which will have either carcinogenic or toxic, non-carcinogenic effects, . Some compounds can lead to cancer and also other non-carcinogenic effects that is something to keep in mind. So, cadmium, cyanide ; I am surprised arsenic is not here, they would have probably classified that here. That is another surprise.

I am surprised arsenic is not mentioned, because that is a considerable issue in India, at least, maybe it should be in one of the parameters somewhere, but probably I am unable to find that out. , you can look that up it should have arsenic somewhere or the other. So, let me move on. So, here you have the toxic compounds are relatively more toxic compounds, that is why you see that the acceptable limit is much, much lesser here.

And we talked about the disinfection by-products. So, that is why we see the trihalomethanes which are one class of disinfection by-products which are given here. In India, we have at what 0.1 milligram per litre for bromoform which is 100 nanogram per litre or 100 ppb. Here is total arsenic as you see it is pretty low 10 ppb and same case with chromium, total chromium, white, total chromium or total arsenic because arsenic and chromium exist in different oxidation states.

Here, we are talking about total chromium and total arsenic. A typical way to analyse these heavy metals is by using AES or ICP-OES or ICP-MS . A cheaper method is to use AS, atomic adsorption spectrometry. So, we have the trihalomethanes, radioactive substances, rarely will they come into the picture so, I am not going into that. So, pesticides typically based on Indian context or Indian or information from, what we say, or experiences from India, so, that is why we look at these particular compounds.

And here, we come to the bacteriological quality, not that we are talking about E coli, thermotolerant, so on and so forth, coliform bacteria. In general, we do the total coliform

bacteria, let us see. , why are we going to look at total coliform? Why is it? And in this context, I think we need to mention that we looked at total coliform and faecal coliform to relevant, what we say test, total coliform and encompasses this faecal coliform.

Faecal coliform, we look for I think in sewage, when looking at sewage treatment plant and water from that and here we look at total coliform . Total coliform , why is it? Because these are indicate off, , gut bacteria are faeces coming in contact with this water or contamination due to human faeces. So, what is the limit?

As you can see for all the kinds of uses, all water intended for drinking, treated water entering the distribution system, treated water in the distribution system, everywhere you see that it should be 0; not detectable in any 100 ml sample. Why 100 ml? Because it is based on the MPN test, . But , in any 100 ml sample, it should not be present (16:48). So, that is the relevant aspect. So, let us move on or come back to where we were **(Video Ends: 16:55).**

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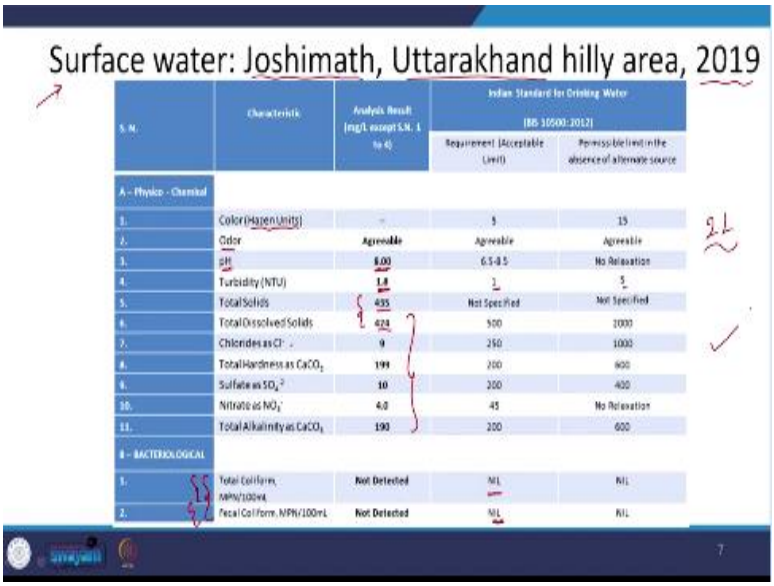

So, let us get this started. So, sample water quality report, I think from IIT Roorkee of water from Joshimath, but I think lower Himalay Uttarakhand hilly area recently, . Let us look at what we have. When we say water quality, typically, at least this is what we do or people in our lab do. What are we looking at colour? We are typically not measuring that unless it is visible, then we do that has an units, there is a particular way to be able to do that with the spectrophotometer.

Odour, just by what we say using the nose and pH is 8 relatively high. , that is characteristic of water that is what we say from the springs or so, higher. It is not in contact with high levels of carbon dioxide maybe or with other deposits that can lead to decrease in concentration of H plus or increase in concentration of H plus and thus, decrease in pH.

So, turbidity even there, we see that it is 1.8; acceptable limit is one and here 5 but please note that this is from the stream without any treatment. So, along with the flow of the stream, maybe some particles would have been kicked up but you do see that there is still turbidity. In general, we look at turbidity as an indirect correlator or variable that has correlation with coliform or the pathogens.

So, , we will come back to that later. Total solids 435, total dissolved 424. Keep in mind that if we look at these values and sum them up and play around, sometimes these values might be off, but the issues that when we are looking at this test, typically they take 2 litre water and then try to , distil not distil, filter and then put in the woven .

But , the accuracy is going to be pretty much affected, especially when we look at these concentrations, which are so low, . So, that is one aspect to consider chlorides pretty to be less and all other aspects are within the reasonable limits, .. So, that is something to keep in mind. And more importantly, what about the total and the faecal coliform here we seem to be measuring both.

In general, total coliform is what you measure. , both came up to be nil. So, this water is good for consumption without treatment too. So, that is one aspect to keep in mind. Maybe if there are, , sand particles or such, you can filter it with the cloth, but you can use this.

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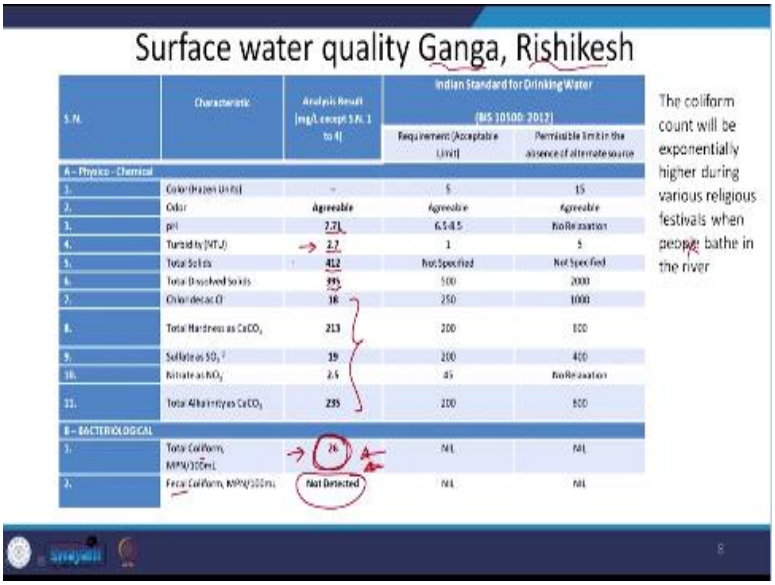

But when it comes to Rishikesh, water the quality of Ganga at Rishikesh, what do we see here? pH is relatively less expected. Turbidity hcreased; it can be due to the suspended matter or due to other aspects which we will look at later. Total solids dissolved solids seem to be fine. All the other aspects to be more or less fine. But as you can see, the issue here is that total coliform, , 26 even though faecal coliform have not been detected.

You do see that total coliform is there. So, it is indicative of, , gut bacteria or contamination by your human faeces . If not human faeces, more or less gut bacteria, if I may say so. So, this water is not fit for drinking. And one other aspect is this coliform, both maybe faecal and total will be exponentially high when we have different religious festivals. When people have or come to bath , , we have the mela .

And that is when you are going to have to be remarkably high. So, you see the relevant aspect, even though the water might look good, you see that we have or we need to be concerned because there are considerable indicators that say that this water has pathogens and that is one aspect to keep in mind. And in this context, you need to look at turbidity. Turbidity, , looks at what we say, how well the light is being scattered by the particles in that water.

And typically, we look at a particular size of the particle, I think 50 or 5 micro metres or microns. And that particle size is more or less very much near the particle size of most pathogens. And that is why turbidity in drinking water or at least in treated water or even in

general water from the surface, you can use that as an indirect correlator for the pathogens. , we will come back to that later. But I wanted to mention that now.

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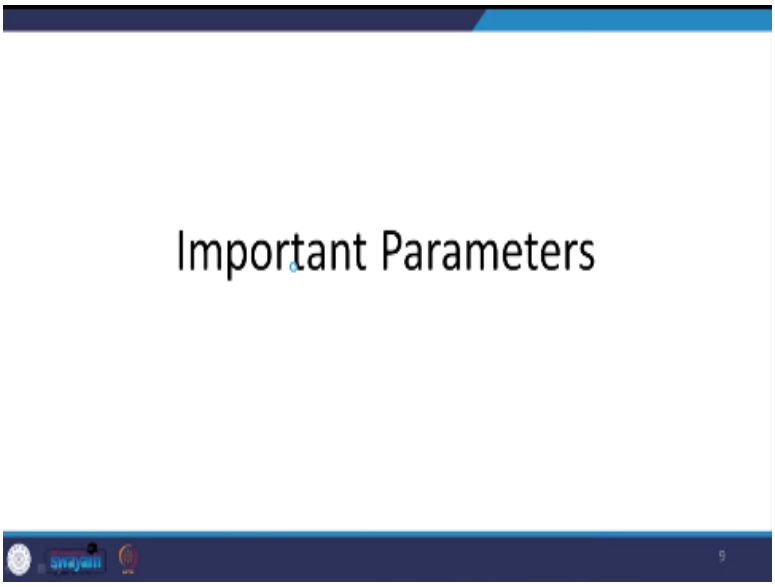

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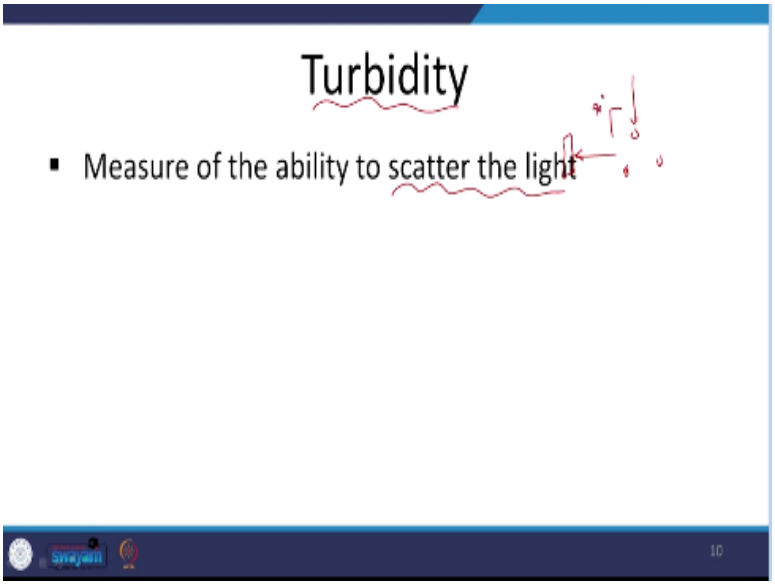

So, what are some of the other important parameters? So, turbidity. What will it give me an idea about? It will give me an idea about the ability of the water to scatter the light. Why is this concern? So, I have the small particles in water. So, it comes through this particular test, well, how this detector here said that 90 degree angle? How much light is being scattered? That is what it will measure.

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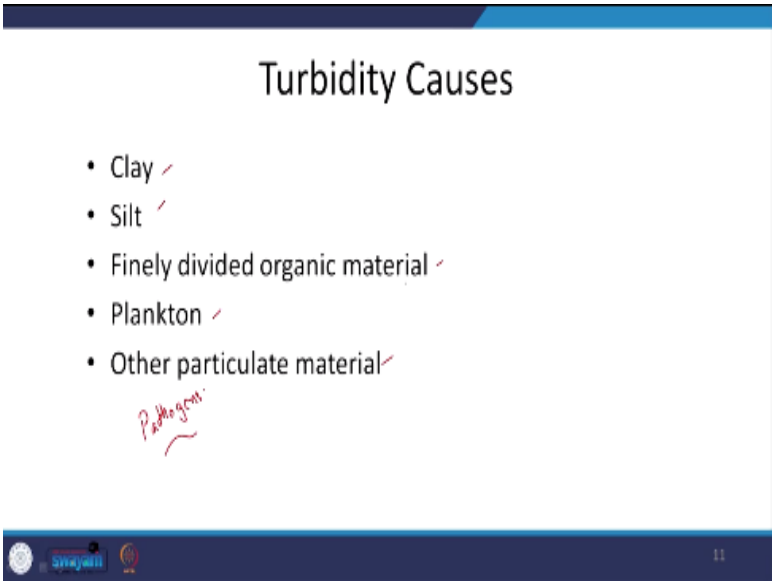

So, what are the causes it can be inert, like clay, silt and some organic matter which is not inert, it can be plankton, it can certainly be pathogens. Some pathogens and other particulate matter. So, on these organic or especially on particulate matter or on clay, you can have pathogens thriving. So, that is one other aspect to be aware of..

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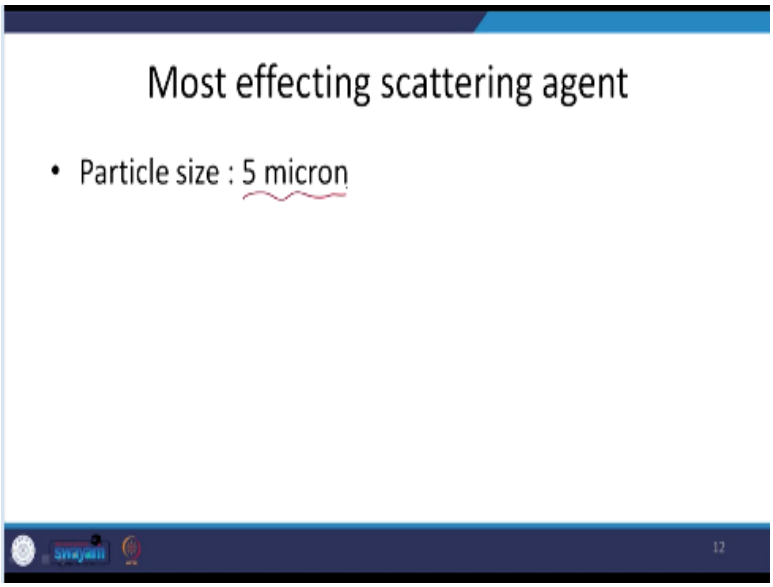

So, most effective scattering what we say, agent. The size is 5 microns as I mentioned earlier and this size closely matches with the size of your, what is it, pathogens .

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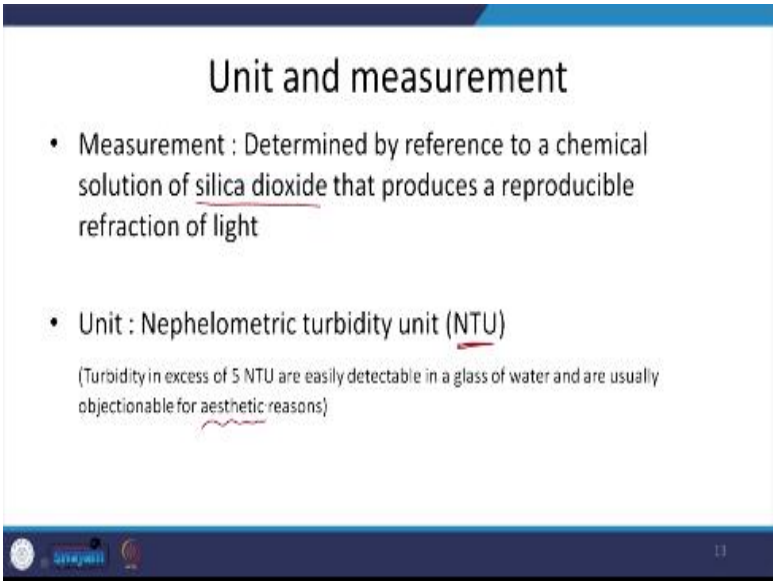

Unit and measurements, we have a turbidity metre, which is pretty easy to use. And the reference is the solution of silica dioxide, yes and we use turbidity metre, the units are nephelometric turbidity units or NTU that was what you see. And Turbidity in excess of 5 are easily detectable in a glass of water and are objectionable for other reasons such as aesthetic reasons. So, that is something to keep in mind. Let us move on.

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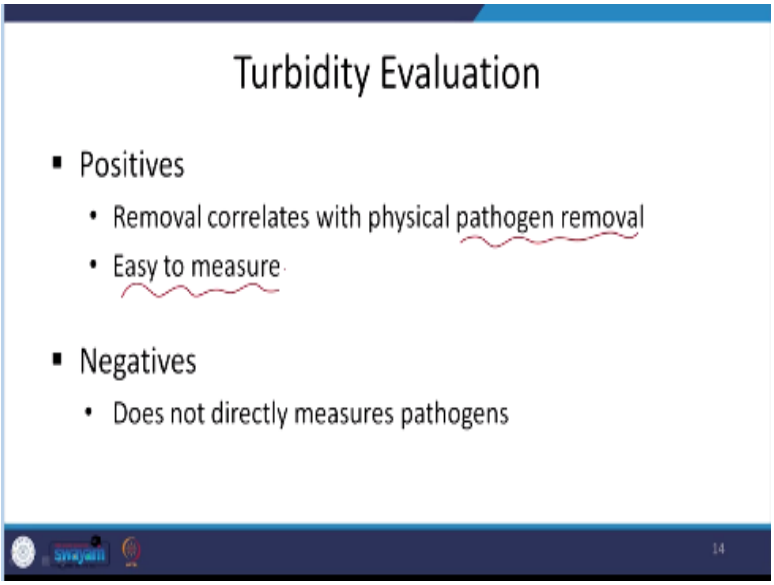

Why do I need to look at turbidity? As I mentioned, it correlates pretty well with physical pathogen removal, turbidity 10 and pathogen of , 100 or so. Turbidity 2 or 1 and pathogen have almost 0 or 2 or 3. So, that is one aspect it correlates pretty well with physical pathogen removal. And more importantly as I mentioned, even you have these hand help portable turbidity metres.

It is pretty easy and cheap to measure. Negatives , it is only an indicator which correlates; it does not directly measure the pathogens. Something to keep in mind.

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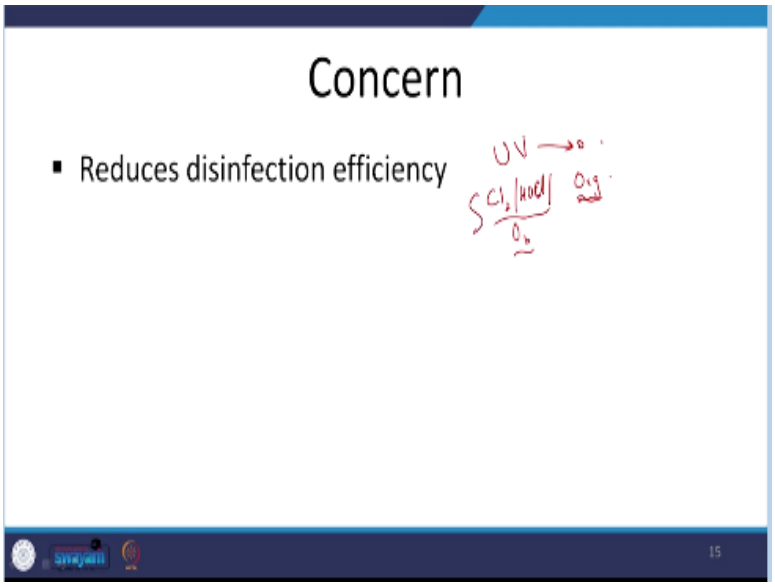

So, another aspect is, as we looked at, we can have UV and if we have UV and turbidity, why UV? I want to disinfect the water and my relevant pathogen is here, my pathogen is here. So, the UV will be adsorbed by the relevant particles leading to turbidity or the pathogens will be shielded from UV. Same case if you have organic content, organic matter and I add other oxidising agents such as chlorine or HOCl or ozone.

These organic matter which will be taken up by; can be measured indirectly by turbidity suspended organic matter anyway, well consume the oxidising agent thereby limiting the disinfection efficiency. Something to keep in mind.

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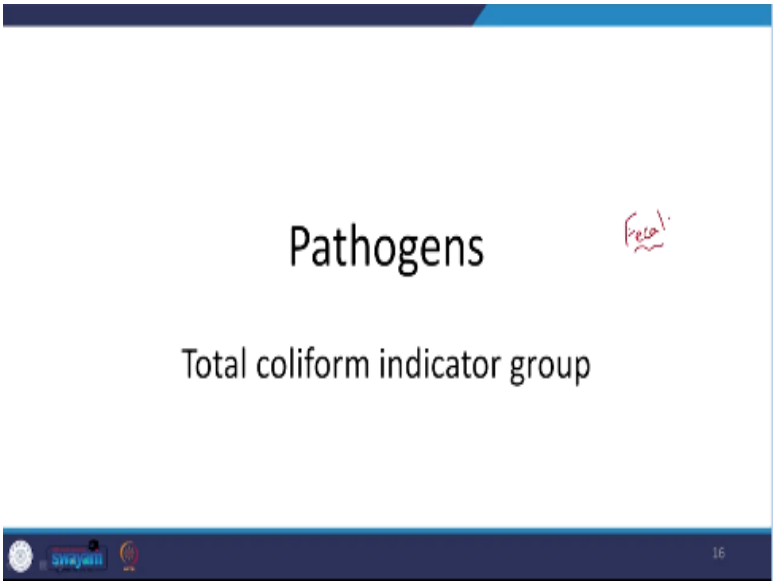

So, pathogens typically we look at total coliform. We do not look at faecal coliform. Faecal coliform is a subgroup within total coliform. So, it also includes what we see microorganisms from roots of plants if I am not wrong and also from the guts of warm blooded animals, which includes human beings too.

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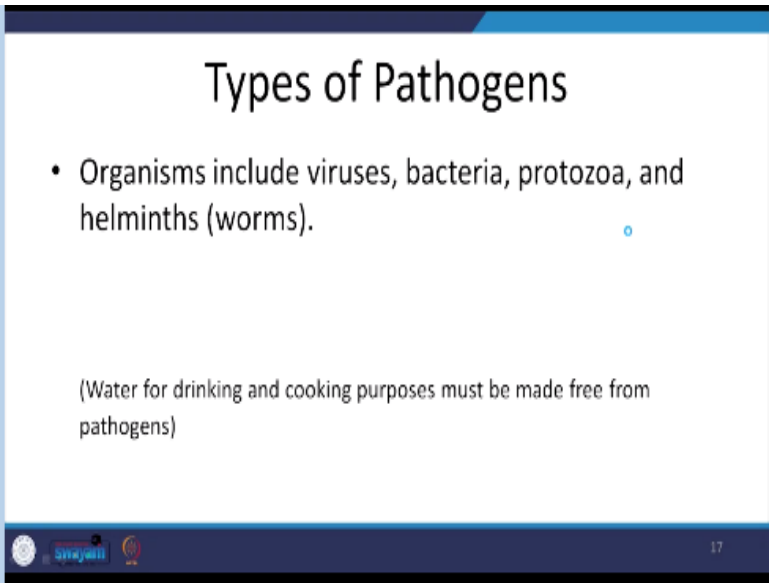

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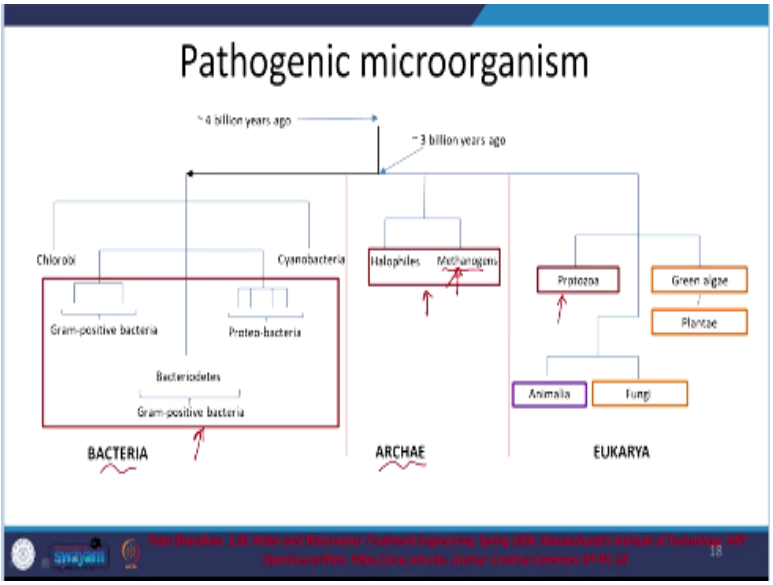

The organisms include viruses, bacteria, protozoa and helminths, yes and in general, we looked at this figure earlier and in general, we are concerned with these bacteria, some of which can be pathogens, the ones highlighted and protozoa, I think we looked at this cryptosporidium, sporidium and giardia. And in the context of environmental engineering, especially in the context of anaerobic treatment, we look at pathogens.

But typically ARCHAE, , they are not a concern with respect to drinking water quality with respect to health concerns . But we are concerned about these bacteria and some of these EUKARYAS, . So, that is something to keep in mind. , viruses too, viruses, which are not mentioned out here. let us move on.

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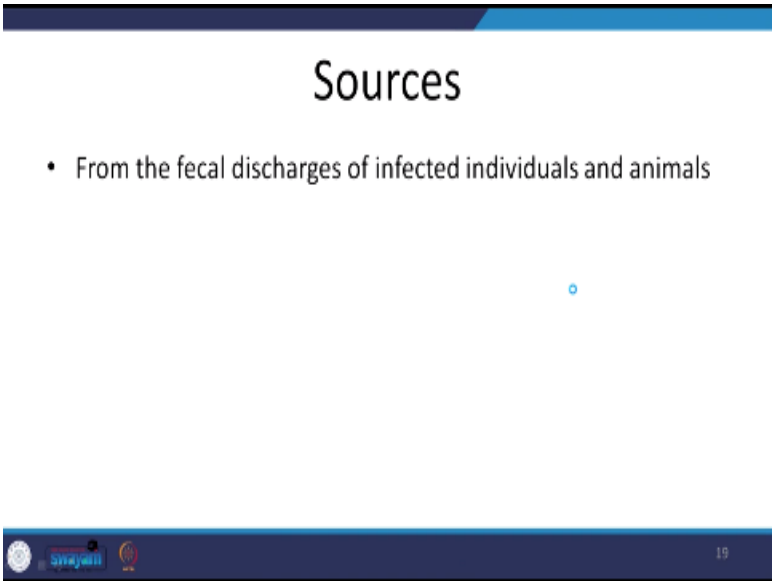

So, what are the different sources by which , you can have contamination of the water by pathogens. Typically, it is the faecal matter of an infected individual coming and mixing with the drinking water of another human being. So, that is what we have out here.

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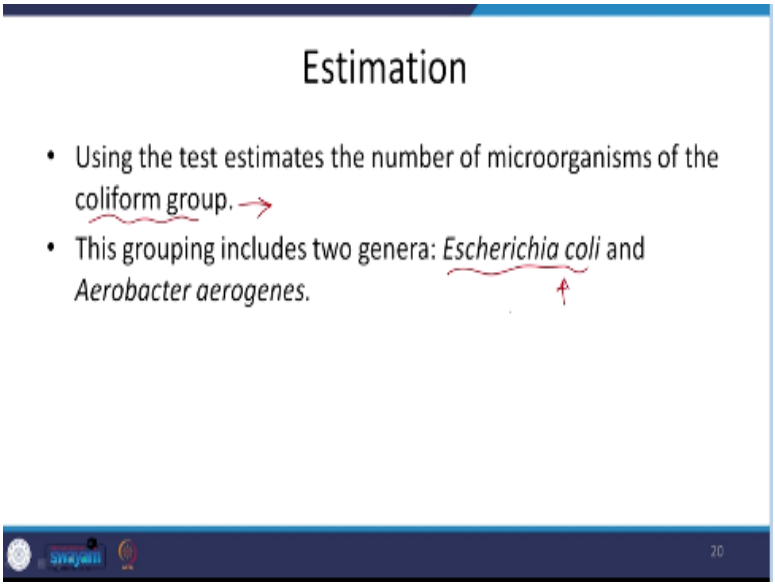

And this test in estimates the number of microbial organisms of the coliform group, which are an indirect indicator or indicator of pathogens. Why do we look at this coliform all this indicator organism? Why did we or people choose coliform? Because it correlates very well with the pathogens that we release or from which are from our gut or from our faeces, it correlates very well.

And equally importantly, it thrives well outside our human body, it is not as if it thrives for longer time only in the body, then if I cannot measure it outside in the environment or water, it is of no use. So, it can thrive well there. And it is easy to measure too well too easy, if not very easy. So, these are some of the aspects why we choose to measure or look at the coliform group to understand or to try to see the presence of pathogens.

And this looks at E. coli for which we also find a mention of which we also find a mentioned in the standard and the aerobacter aerogenes .

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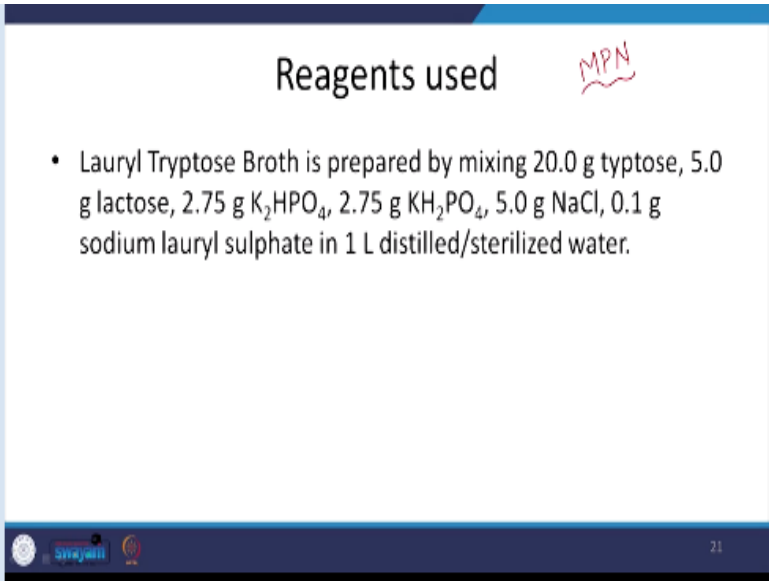

And reagents used in this test, typically we look at there are other tests, MPN most probable number, that is what we typically look at, a specific type of broth that is conducive for these coliforms is prepared. And we have the tiptose, lactose and different phosphates and nutrients.

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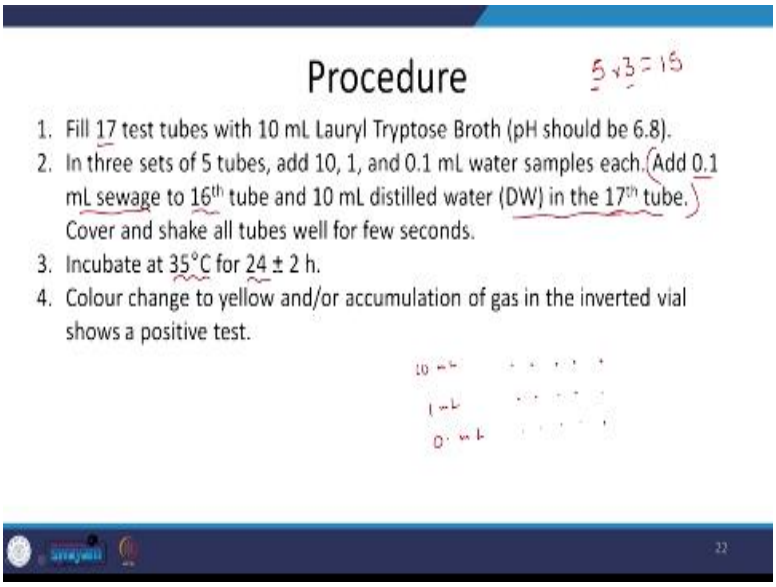

And you prepare that , you do not need to muck this up and you are going to fill 17 tubes, but in general, it is 5 x 3 = 15 + 2, why 2 we have 16 tube, where we add sewage, so that we know that it whether the test is coming out to be or not, so that it is a reference. , this is not standard or required. But that is what we do in our lab here. And 10 ml of distilled water, to see that there is no false, , negative or positive, pardon me.

Cover and shake all tubes, well, for a second. So, in these sets, 1 2 3 4 5; 1 2 3 4 5; 1 2 3 4 5. So, in the first one, I add 10 ml of the waste water; the second one, I add 1 ml of the waste water. In the last set, I add 0.1 ml of waste water and also, I add this Broth that we prepare, . And then we incubated at a particular temperature that is conducive for growth for a sufficient period which is 24 hours.

So, when the colour changes to yellow due to the acid I think being produced or accumulation of g the inverted while it means that there is a positive test. So, you can have sometimes depending on the kind of sample, you can have a positive result here, but negative results in all the point one samples here. Why? Because it is not that you have uniform distribution of the pathogen in the relevant or the coliform in the relevant sample.

So, here, there is, I would not say guessing work so, statistics is involved. But , you have what we say tables that will give you an idea about how to get this number, we will look at that soon. So, let us move on estimation technique pretty simple.

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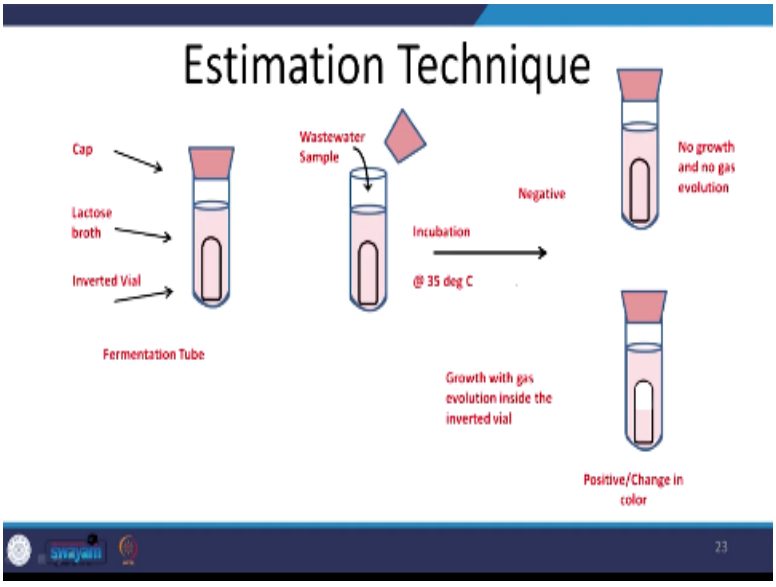

So, lactose broth inverted while to capture the fermentation products, the gas and fermentation tube . And waste water is put in 10 ml, 1 ml or 0.1 ml, incubated, if it is negative, this is what it looks like. If it is not negative, you have gas and also you will have some colour change here depending on the type kind of test.

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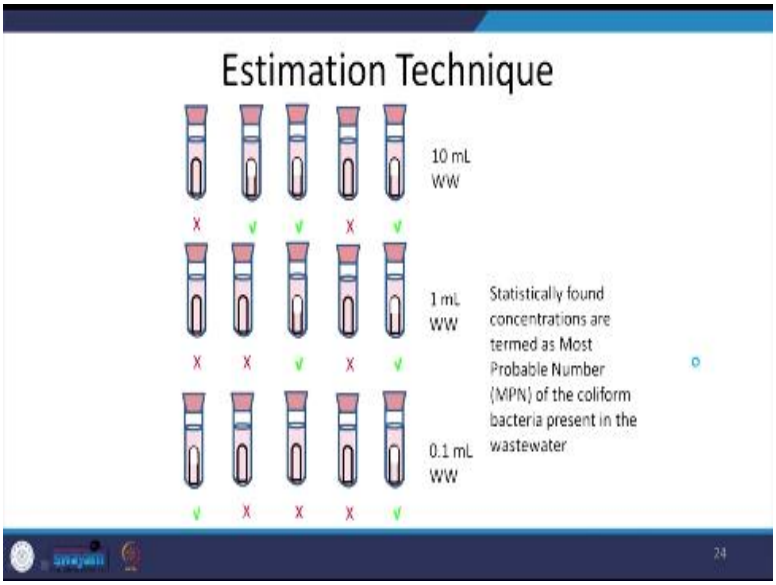

So, you can have positives here, positives and positives 10 ml, 0.1 ml . So, based on that we are going to look at it.

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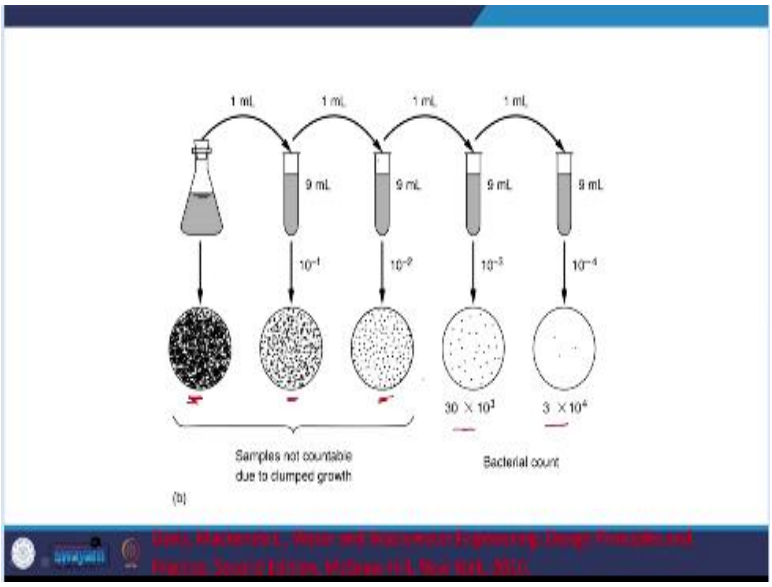

So, in general, what does it mean? Let me also look at. So, waste water, so we are diluting it by 10 times each, each time each step, we are diluting it 10 times, so the microbial count or the microbes also it is supposed to decrease so, that is what we have. Here, there are too many to count too many too many to count, , though we are not actually counting, some people can do this, you can count the, you can also come up with the bacterial count. But , that is not usually done, but can be done.

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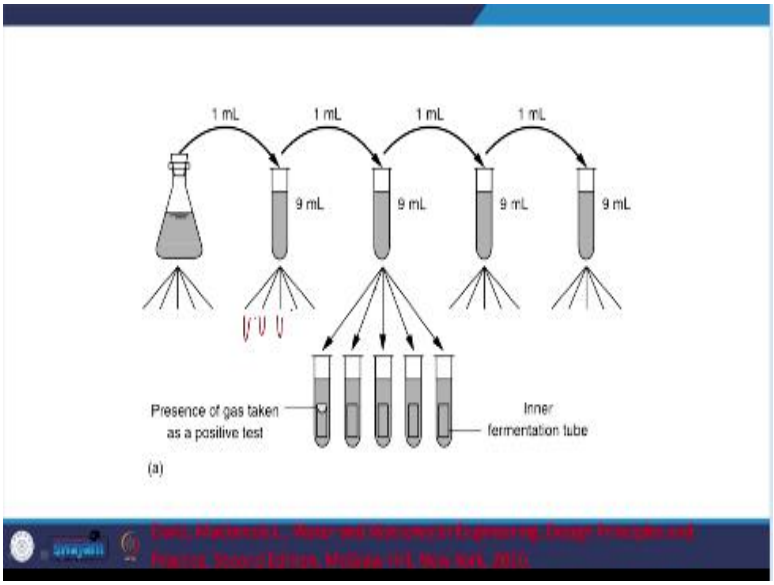

Usually, what do we do? This is what we do we try to see to it that we put that dilution into this tubes for our MPN test . So one set is out here. So, different ways you can count, but this is what we do in general .

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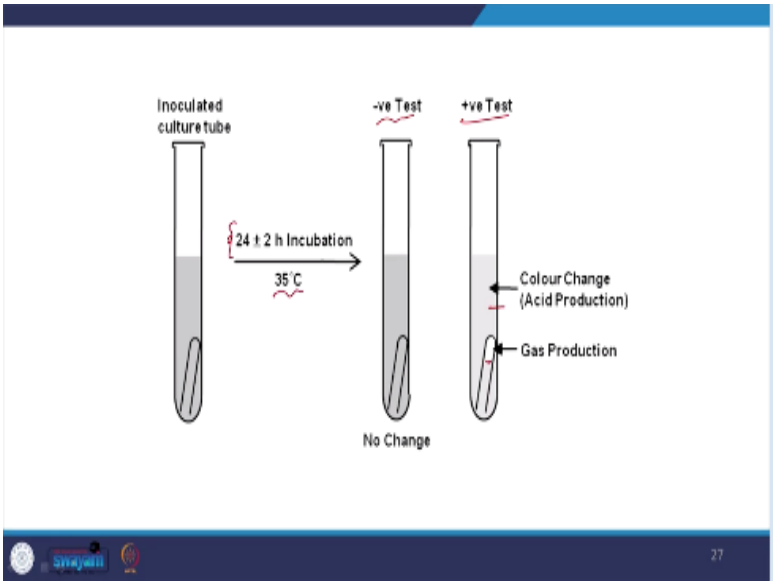

And where is the data? As we mentioned, if there is gas production and colour change due to acid or acid production, positive test; if there is no change, negative test. , we are going to incubate for some time at the temperature.

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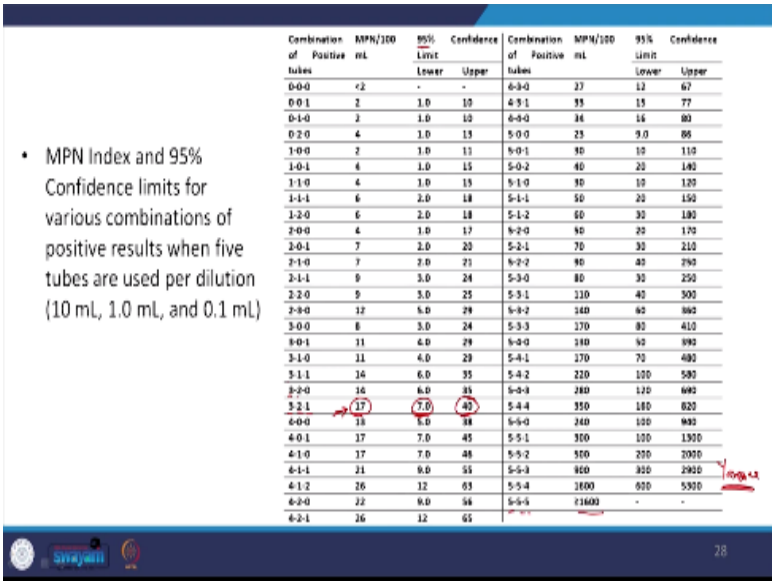

So, how do I get this? As then, how do I get the MPN? Here, it seems like it is 3, 2 and 2, out of 5. So, how do I get it? So, here we are going to I think, use the tables based on the Poisson distribution. So, here for a 95% confidence interval, here we are not saying with 100%, , assurance, but it said 95% guarantee, . 95% confidence, .

So, we were looking at I think 3 to 2. So, where is 3 to 2? I cannot find 3 to 2 here. So, when we let us assume that it is 3 to 1. 3 to 1 Yes. So, MPN is 17, . Per 100 ml, that is what we have 95% lower limit is 7 and upper limit can be 40. So, but typical one is 7, but lower limit is 7, 17, pardon me, lower limit is 7 and upper limit is 40, . So, based on different, , combinations of positive tubes, you will come up with this most probable number from this particular data, .

So , if it is all 555, you cannot just say it is 1600. This you will see in Yamuna I think where MPN will say that it is in lakhs and lakhs , I think, if not millions. So, that is because considerable untreated or partially treated sewage from areas surrounding Delhi, which are not covered by Delhi sewerage network will come into Yamuna downstream of Yamuna.

So, if you take a sample downstream of Yamuna, you will see that it is remarkably teeming with different kinds of pathogens and microorganisms. In that case, you will have to dilute that water a lot. Before you conduct this test, . If it is all 555, what do you need to do? You need to dilute it so that you can do more measurable range, .

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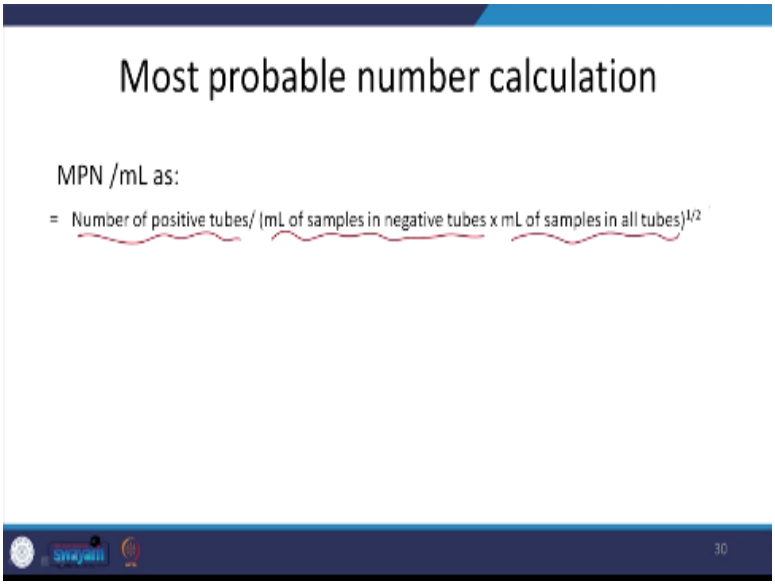

So, estimation technique we already covered that. If not another way is number of positive tubes by the ml of volume of the sample in the native tubes, volume of samples in all tubes square root . So, this is another way to get the MPN number.

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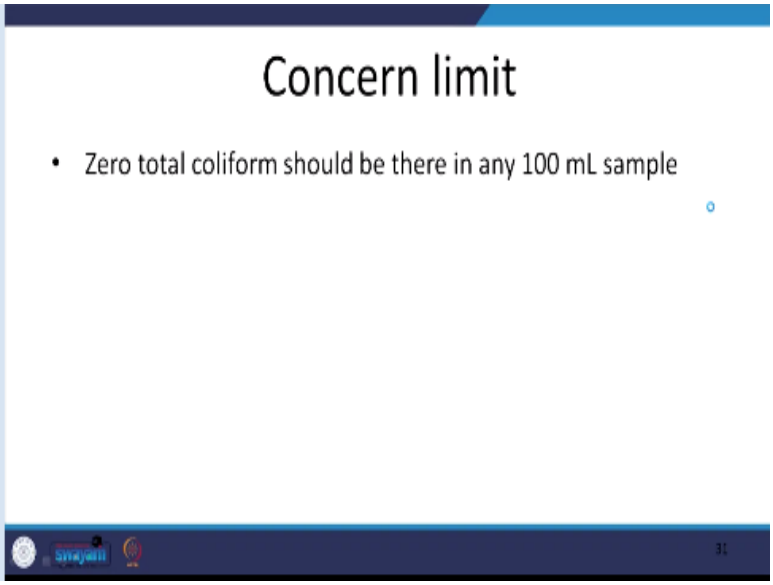

So, as we mentioned, what is the limit I need to be concerned about? It has to be zero in any 100 ml sample.

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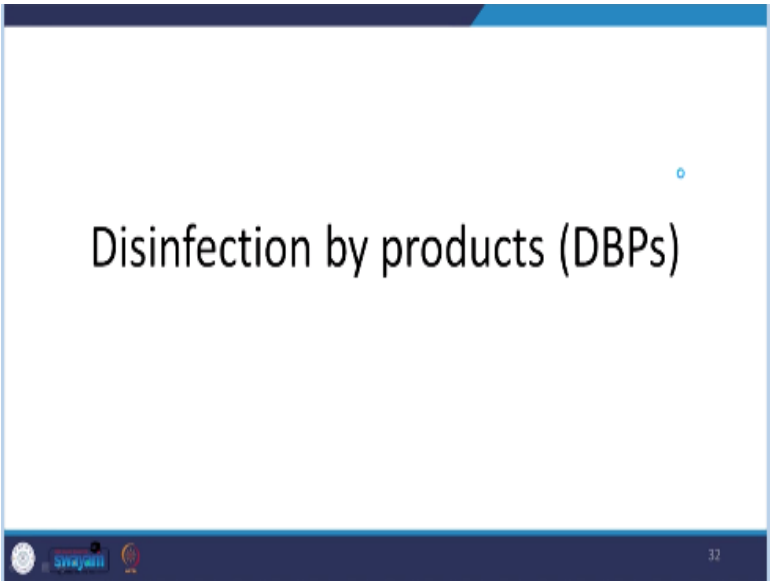

So, disinfection by-products, let me try to get this done, because we already looked at this earlier. So, why do I need to be concerned about it? We already discussed this in the context of waste water. I specifically mentioned, let us not chlorinate what we say waste water that is being discharged. But people do that here due to dubious reasons, when they cannot degrade the waste water well enough, but want to show the relevant regulatory agency that they can treat the water what do they do, they chlorinated.

When the chlorinated , the chlorine, which is an oxidising agent can oxidise some of the organics, but you have very toxic or constantly toxic DBPs that are released into the aquatic stream, . For waste water there are no standards for DBPs but that is what we say remarkably foolish thing to do from the environmental point of view, but people do not care a lot.

But with drinking water, it is toxic to me. So, as we saw in that Bureau of Indian standards, we had the relevant limits specified for one class of it.

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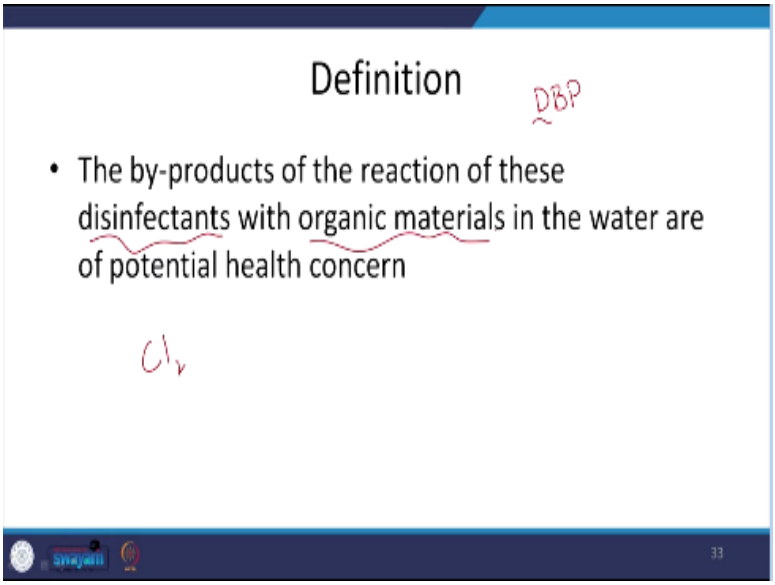

So, we already looked at this how do we have we are this form disinfection by-products. So, by-products of disinfection, when I am adding a disinfectant, typically Cl_2, HOCl or such when they react with organic materials, , we have this we already covered this in detail when we looked at the relevant DBP formation in the context of waste water or disinfection of waste water.

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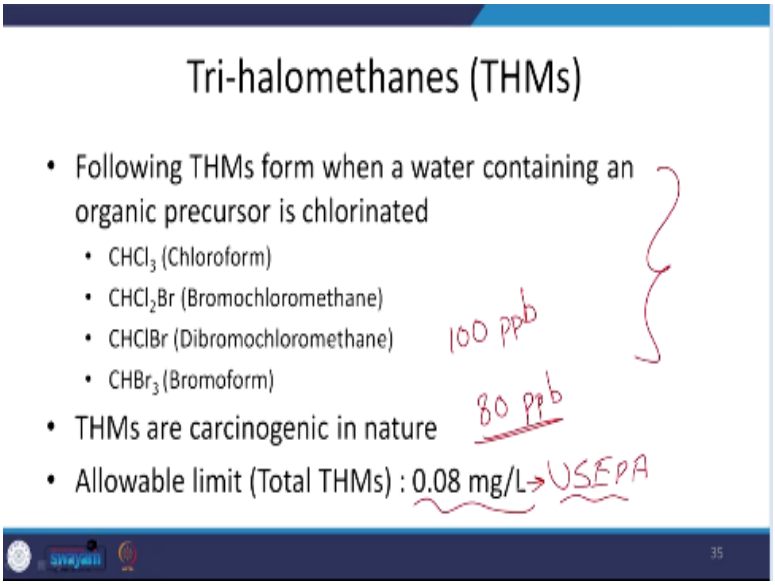

So, types of DBPs in India, at least, trihalomethanes are what we say, regulated. So, I think this is not from Indian context. Let me just check away. **(Video Starts: 34:43)** Where do we have that? So, we have much higher standards out here. **(Video End: 34:50)** So, this is I think, from US EPA, my TA might have forgotten to remove it. So, as you see their standards are pretty low 80 ppb.

But for us, for each one itself, we have it 100 ppb or so total is 500 acceptable. But , that is because our plants and our standards are still , not up to scratch, but you see that , we want to improve the quality of life, then , we need to look at these aspects too. This is not from the Indian one, I think this is from US EPA. Indian one, we look at the relevant standard.

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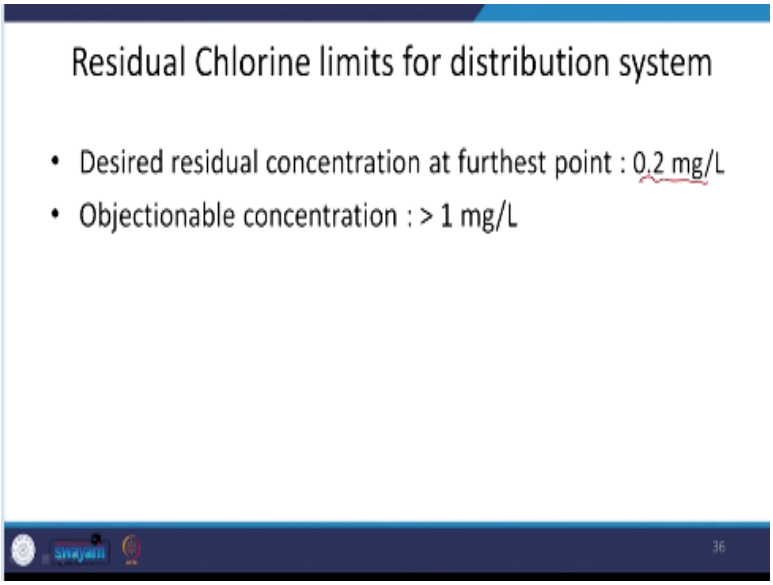

So, residual chlorine, typically we want that. Why? Because otherwise, if you have pathogen entry, re-entry into the distribution system or entry into the distribution system or microbial growth, you can have issues at the consumer end so, that is why you want to have some residual chlorine, even at the furthest point, but if it is too high, it is going to be objectionable, chlorine is a strong oxidising agent.

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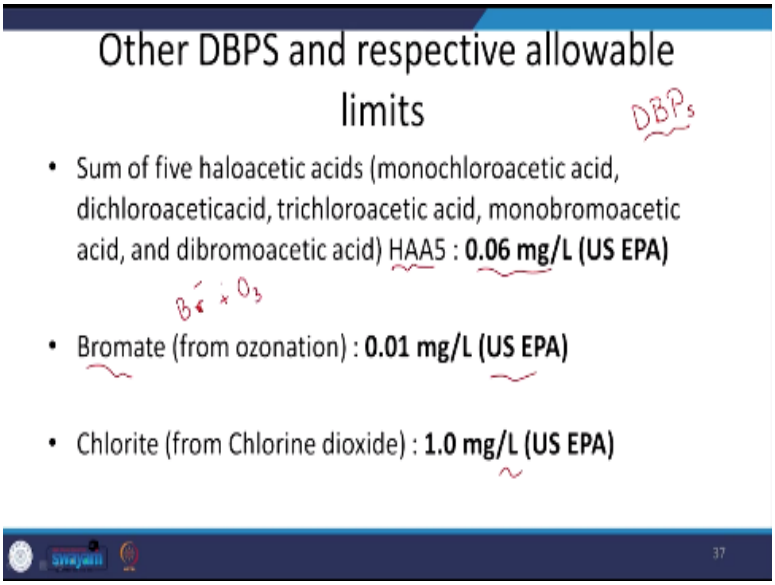

So, there are other , other disinfection by-products which are not regulated in India due to various reasons, but for example, like hollistic acid for which in the developed countries, we have the relevant standards, but India, we do not have that. So, that is something to keep in mind, . , bromate formed when we have minus, reacts with ozone that is also regulated there.

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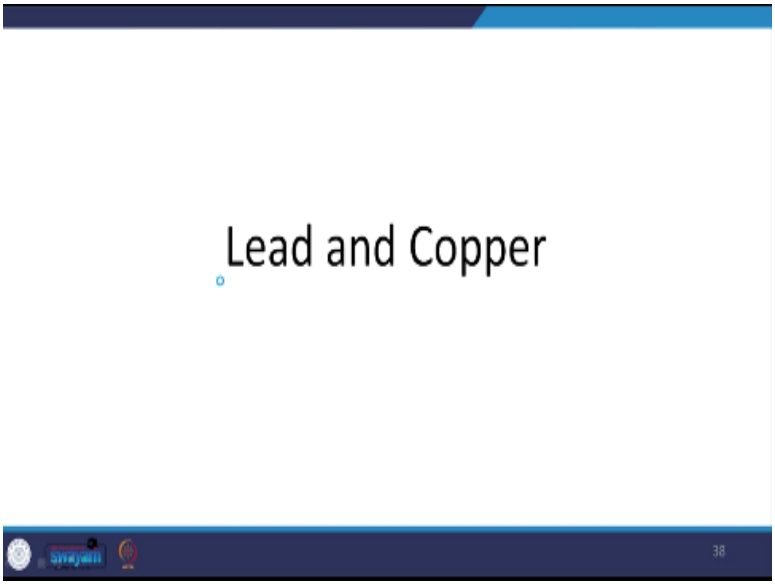

So, lead and copper have greater concern in the US because earlier they used to have lead or copper pipelines.

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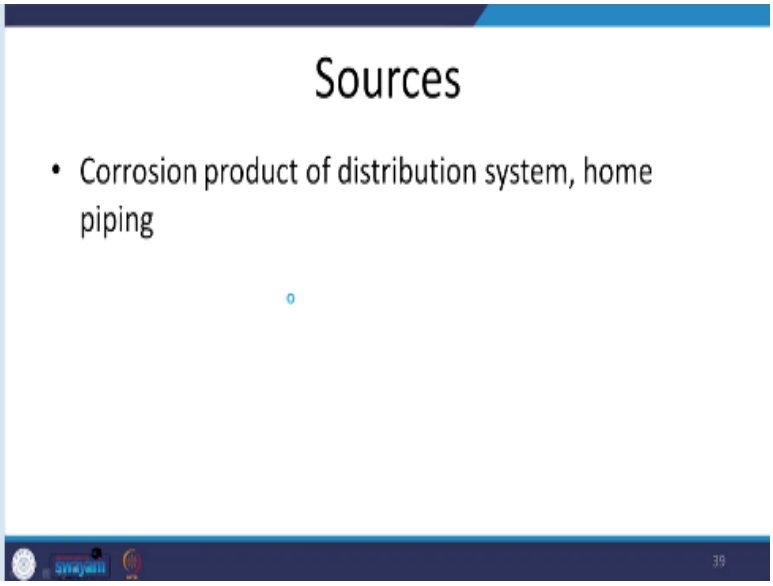

So, corrosion product of the distribution system, typically water can have an oxidising capacity and it can lead to corrosion of your relevant water this pipeline or , relevant aspects.

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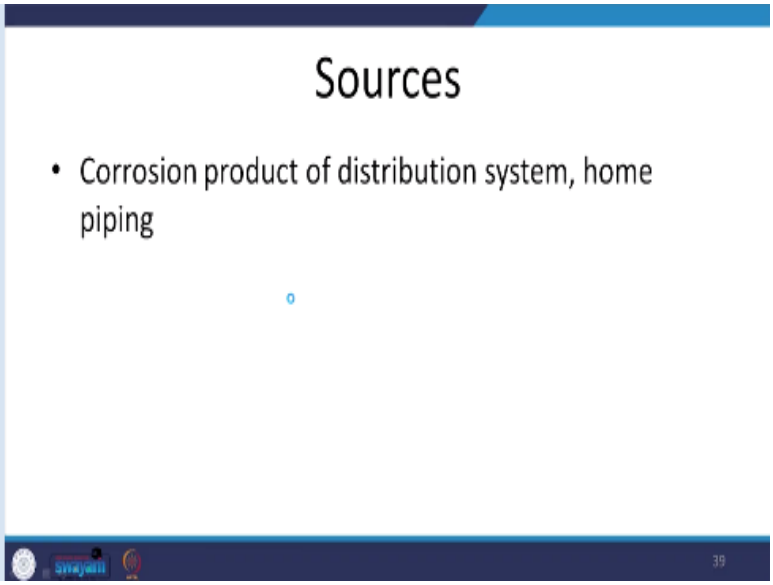
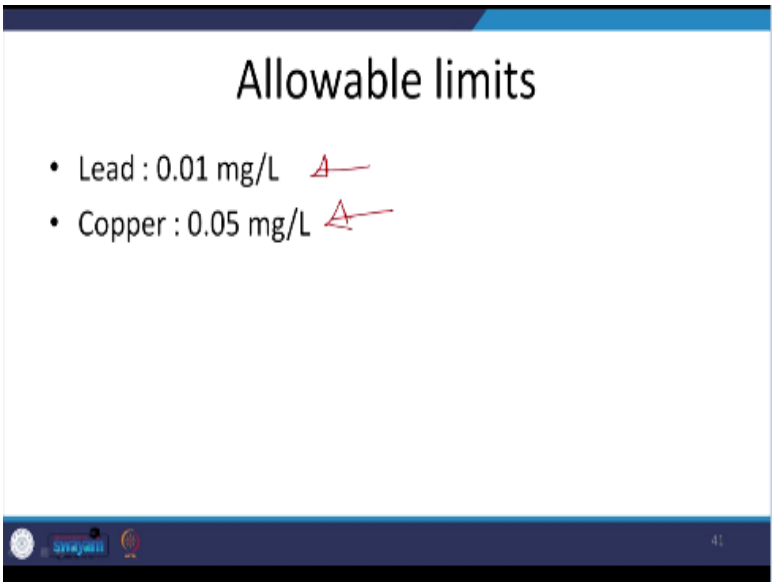


So, what are the side effects? Interference with red blood cell formation, certainly kidney damage and then cognitive performance, is also going to be affected cognitive performance, . **(Refer Slide Time: 36:40)**



Allowable limits, , hopefully, these are from Indian context. Let us have a quick look at that. **(Video Starts: 36:57)** We are looking at lead 0.01 **(Video End: 36:59)**. So, it looks like they did get it this time for India. These are the standards , as you so see, they are pretty less. , these standards are developed based on the risks associated with the particular compound to the particular human.

We will not go into that. But , we now understand the kind of water that we want to be consumed. But one aspect to notice that when we do a drinking water quality test, we will not look at all these 100 or so parameters, we will look at the usual few. And even then if you

suspect something, then you need to dig deeper, but then the costs increase. So, with that, I am out of time for this session, so, thanking you for your patience. I will end today’s session.