Water Supply Engineering
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Lecture 24
Philosophy of Water Treatment

Hello Friends. This particular week we have been talking about water quality and treatment and in earlier lectures we did talk about basic importance of water quality, what are the different sources of contaminants that can come into the water and in previous class we discussed how do we characterise water so in terms of which water quality parameters report the level of pollution or level of substances or unwanted substances present in water. Now in this particular lecture we will be taking a step forward and discussing the philosophy of water treatment.

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And what we are going to cover in this is the basic concepts of water treatment, and the very basic concept of the water treatment and then we are going to talk about the water quality standards, water quality assurance and we will be discussing the basic design of water treatment systems so what are the different treatment process and systems for purposes of contamination removal from water.

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This in fact is an old slide we earlier saw this in a week before we have so far talked about collection of works how do we collect water from the source and earlier week we discussed the transmission works so how we transmit water but one of the as discussed earlier that this are the like collection, treatment, transmission and distribution are the main 3 pillars of municipal water supply system of course in between comes the tranmission. We did not discuss about collection of water but discussed on transmitting water to treatment facility to distribution mains to storage structure.

The important part is the treatment or purification work which is essentially the treatment plant in water supply systems. This particular week and the next couple of weeks will be focusing on the treatment of water. As we know that pollutants create health issues when consumer gets exposed to pollutants from water and exposure can be either dermal or injection. When we drink or eat food or taken bath from contaminated water we get exposed to contaminants thus creating problems.

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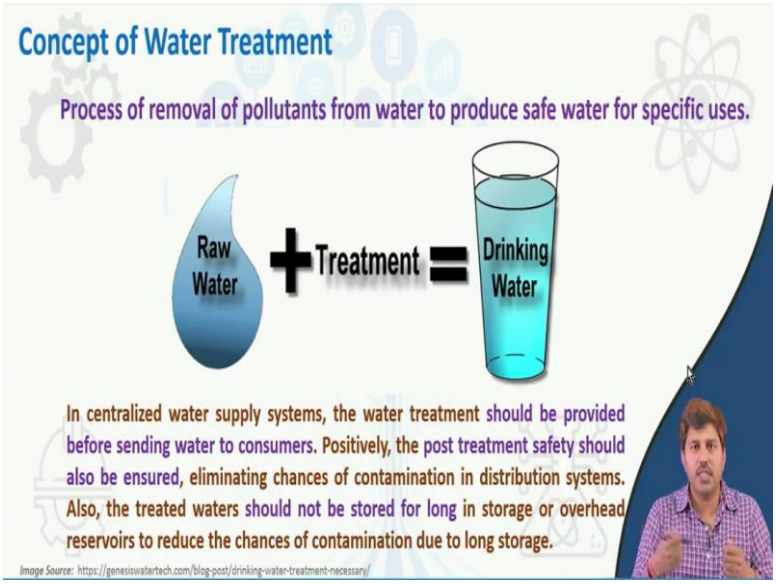

Essentially, when water treatment is required, it is a treatment of removal of pollutants from water and needs to remove pollutants in order to produce safe water for specific uses like drinking, bathing, household activities, for swimming, agricultural or horticultural purpose, therefore water needs to be treated to make it fit for designated specific use. The municipal water supply system has focussed on water to supply for household purpose.

Which should meet the quality for drinking water criteria as it is used for cooking, drinking etc, which is injected through food or other forms. Generally, the criterion for municipal water supply is to meet drinking water standards. Traditionally we have raw water as discussed earlier, raw water sources are probably not good enough to consume directly, and we need to provide certain treatment to process in order to convert it to drinking water.

In centralised systems water treatment is provided before sending to end consumers. Though many of us have the point of view on water treatment systems like RO, filtration, kit providing pure or better quality for drinking and other consumptions mostly for cooking and drinking. Nobody takes a bath from RO water, but many of them have RO and other kinds of filters installed at homes and drink processed water from these units. This is another story.

Generally, in centralised systems or municipal water supply system which is intended water supply to the consumers treats water before sending it to them. Water is taken from the source, treated and then distributed. Positively while treating water we should ensure that

water does not get contaminated after treatment therefore post treatment safety should also be ensured as the chances of eliminating contaminated water is possible to the system

And also to make an arrangement to not to store water for a very long period to the storage structures or overhead reservoirs. As discussed earlier, there might be quality issues in storage level as well particularly the microbial contaminations could be present if kept for a long period so water must not be stored for a longer period after treatment. Let's sum up the points before fixing a treatment set up.

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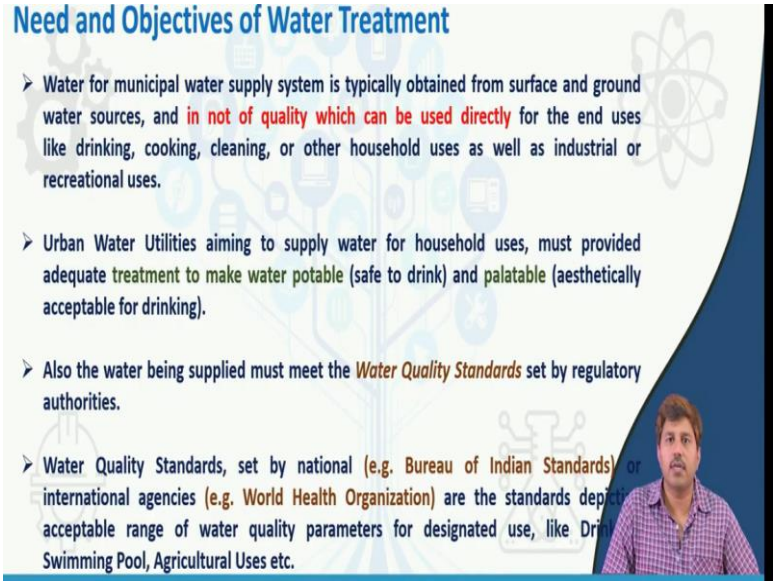

The very basic objective of water treatment is that water for municipal water supply system is typically obtained from the surface or ground water sources. Neither surface nor ground water is of that quality to be used directly. The very basic objective of water treatment is to treat water to be clean, to remove pollutants so that it can be used for end users for drinking, cooking, cleaning or other household uses.

Or the intended supply can also be used for industrial purpose or recreational uses. The urban water utilities which aim supply for households provide adequate level of treatment to make water potable as well as palatable. As discussed earlier also on water rights, the two important point's right to water are to be safe and acceptable. Safe means safe to drink, chemically safe, free from pollutants, free from contaminants.

In other words acceptable means aesthetically acceptable for drinking purpose, there should not be much colour although colour is safe for health prospective but no one likes to see water coloured coming from taps. Therefore, it should not be coloured, any other material, and any sense of odour which are aesthetically unacceptable for drinking purpose. That's the major goal.

Also water which is being supplied should meet water qualities set by regulatory authority. There are national authorities, international regulatory authorities who set water quality standards and these standards provide the quality of acceptable range of water quality parameter. We discussed several water quality parameters in previous week. Some of the quality parameters guide, acceptable range of water quality parameters for designated use.

If used for drinking water, what is the acceptable range of water quality parameter, what would be the acceptable range of water quality parameter for swimming and similarly for agricultural uses? Standards are set by national agencies like in India it is Bureau of Indian Standards (BIS) International agencies ex: World Health Organization (WHO) and United Nations have their own set of standards made by several countries similarly European has their own standards for member nations and US have United States Environmental Protection Agency. (USEPA).

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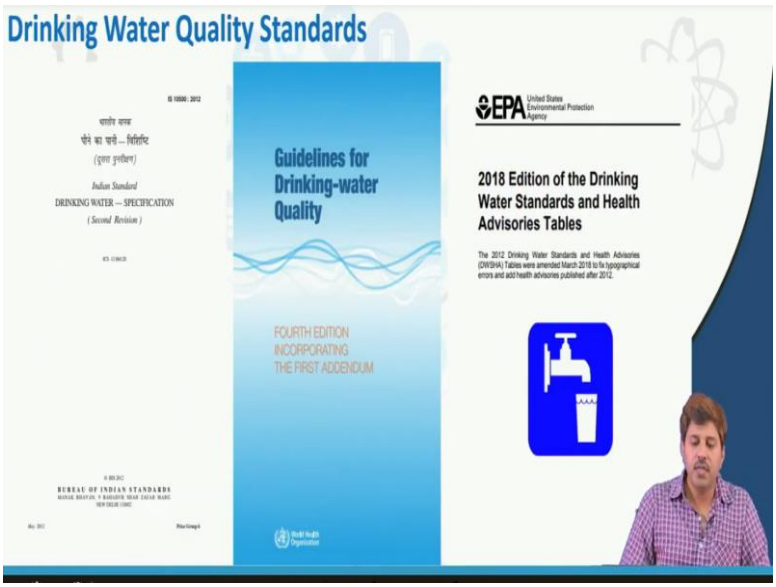

These are the few examples of Standards as said and few sources of BIS, WHO and USEPA can be seen here in the image shown.

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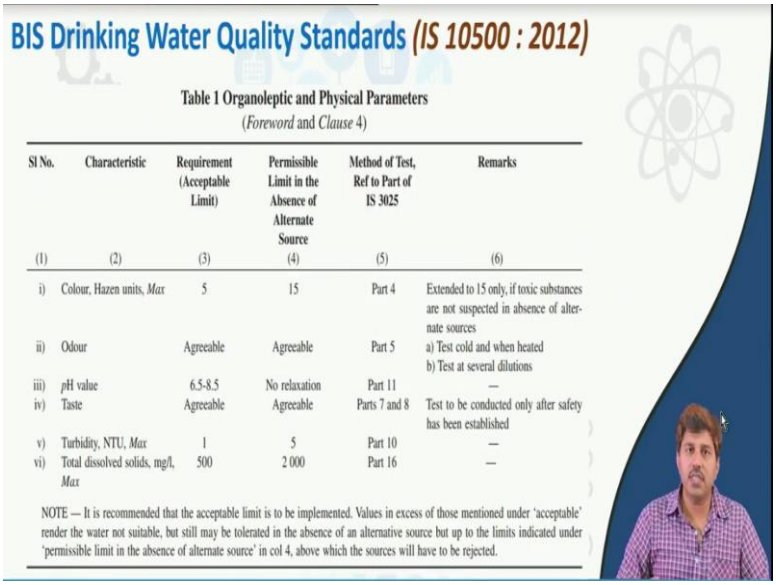

Now, if we see BIS which is applicable in India, is under (IS 10500), the BIS standards in India earlier had limited parameters but, in the expansion, now we have six tables which talks about six different kinds of parameters. The first one is Organoleptic and Physical Parameters in the form of colour having the acceptable limit and permittable limit, Odour should be in agreeable range; pH value acceptable in the range of 6.5 to 8.5; Taste should be agreeable; Turbidity maximum 1LTU relax able up to 5LTU in the absence of any other source

Similarly, for TDS is 500 and relaxable up to 2000. TDS value is considered as one of the important parameters for drinking water purpose and it is seen that it is quite high for drinking water as 500mg/L because essential minerals should be present in drinking water. There should not be low TDS. Generally, people do not drink distilled water, if water consumed is ultrapure, we get (speech not clear 12:54) several important minerals which is essential for our growth.

Therefore, for drinking water we do not want ultrapure water also we do not want to remove all essential minerals from water so we have reasonably high limit of TDS i.e. 500mg/L this can be relaxed up to 2000mg/L if there is no alternate source available. These are the parameters listed in Table 2 which are general parameters considered for substance available in excessive amounts.

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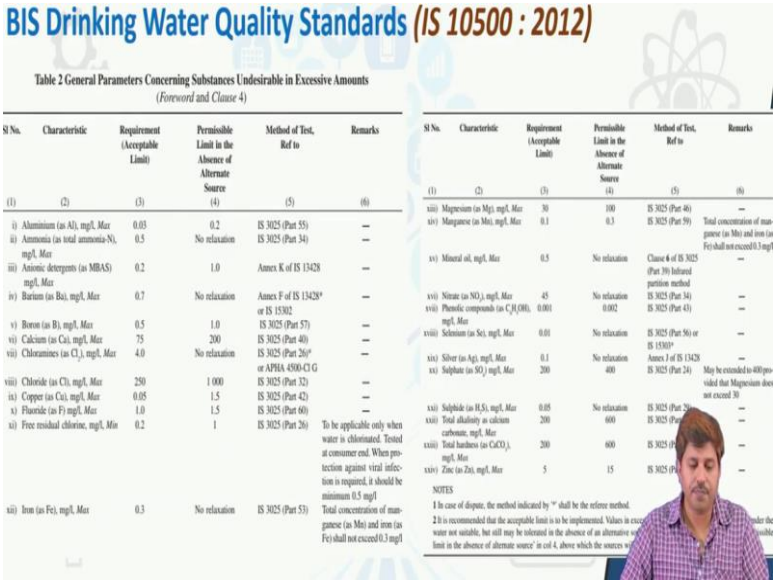

Here we can see a lot of chemicals listed like Aluminium, Ammonia, Anionic detergents, Barium, Boron, Calcium, Copper, Fluoride, and Iron with their acceptable limits. Fluoride is acceptable up to 1mg/L. In absence of any other alternate source it is relaxed up to 1.5mg/L, Iron 0.3mg/L, free residual 0.2mg/L maximum can be allowed up to 1mg/L.

Similarly, Magnesium, Manganese or Mineral oils, Nitrate, Silver, Sulphate lot of parameters including Zinc are the various minerals having their acceptable limit and permissible limits given. In case of certain contaminants which cannot be relaxed like Chloramines, Barium, Iron, Sulphide, Selenium has No relaxation. For some it is relaxed, because BIS does not allow to go for any higher level.

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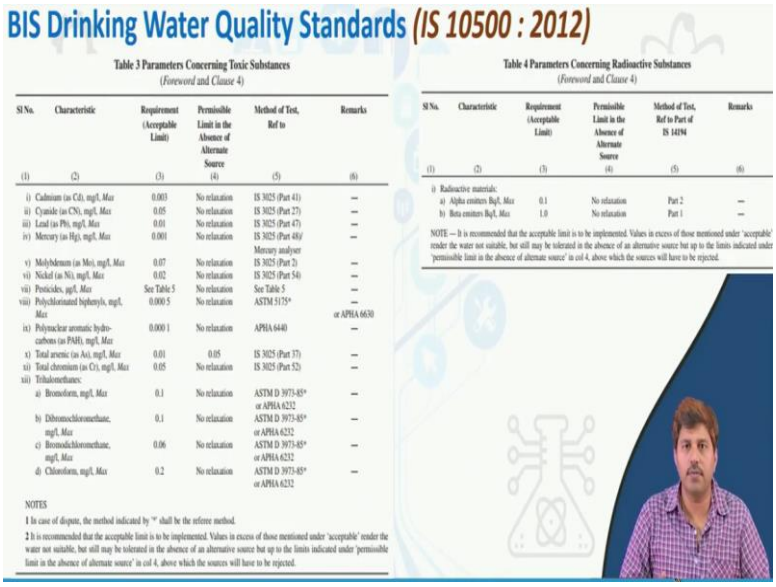

The third table, parameters concerning of toxic substances. Here some of them are Cadmium, Lead, Cyanide, Mercury, Molybdenum, Nickel, Pesticides and various others like Trihalomethanes elements are listed and their acceptable limits of toxics. The acceptable limits are very low for all the cases like Cadmium has 0.003mg/L which is equal to 3µg/L which is allowed. Mercury 1µg/L or 0.001mg/L.

Almost all except Arsenic is allowed 10µg/L and in case any absence of a source it is allowed up to 0.05mg/L which is 50µg/L, because it is very difficult to remove specially in the eastern part of country, there is high level of Arsenic in ground water level therefore relaxation is given for Arsenic by BIS but for other toxic metals there is No relaxation given. Table 4 is for radioactive substances.

Parameters which are radioactive Alpha and Beta emitters – the guidelines are 0.1 Becquerel and 1.0 Becquerel per litre and have no relaxation for radioactive elements and see that these radioactive elements do not exceed the limit. In Table 5 of drinking water quality BIS Standards specially targeted to pesticides residual limits. Various pesticides are listed including Alachlor, Ultrafine, Aldrin, Alpha Lindane, Beta Lindane, Chlorpyriphos, Endosulfan, Ethion etc.

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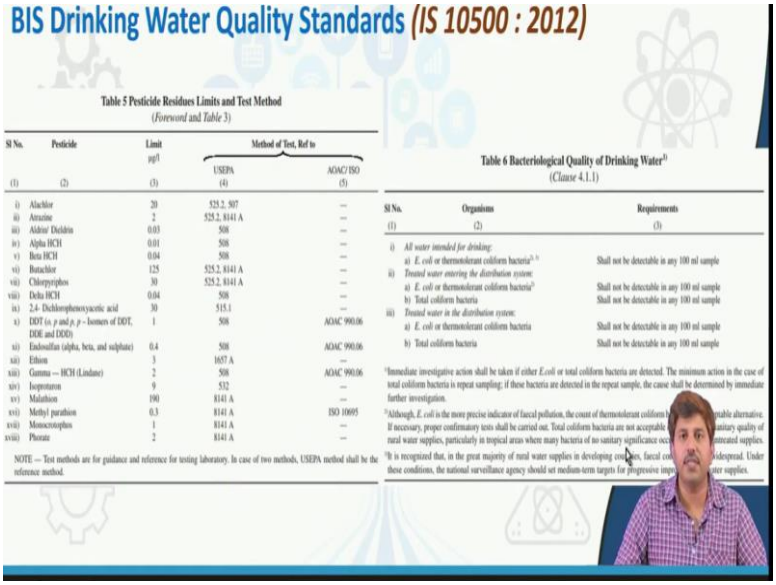

Are listed along with their limits. The limits are very low in µg/L. Pesticides are also toxic and cannot be taken in high concentration and not allowed. BIS provides the guided test methods for these pesticides. Last 6th Table talks about Bacteriological quality of drinking

water acceptable as per BIS. It gives the amount for E.coli or thermo tolerant coliform bacteria, treated water entering the distribution system, total coliform bacteria. Generally, these should not be detected in 100ml sample of water. This is the criteria for bacteriological limits.

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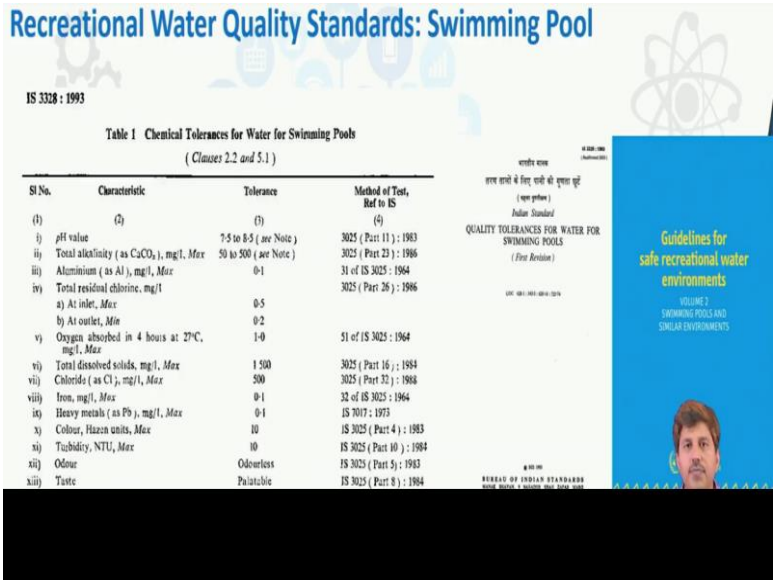

These are the examples scoff drinking water quality criteria. Similarly, we have for designated water quality criteria for other uses for ex: BIS has a criteria for swimming pool water mentioned as Quality Tolerances Water for Swimming Pools. Here are few parameters listed with their tolerance limit: - pH value, total alkalinity, aluminium, iron, heavy metals.

International agencies like WHO have guidelines for Safe Recreational Water Environments For swimming pool water. Similarly, for Agricultural uses there are Standards which must be followed. At several countries these standards are into force. Water utility has to meet these standards. In case of drinking water supplied to households should meet the standards because there is no provision for not meeting the standards that can attend court for the judgements.

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The idea of water treatment is to provide the safe and acceptable also chemically safe and acceptable water as discussed earlier. There are water quality standards available for designated purpose and the supply should ideally meet these standards. But it is not only meeting the standards, should have an assurance of water quality as well. Quality of any other product, quality water which is supplied to end consumer must also be assured, this is lacking with Indian water utilities, and most of them do not trust water being supplied at homes.

In developed countries water is directly drinked from the tap but here, people are sceptical as to water is of good or bad quality that is why there is a huge market for water treatments, household water treatment units like RO and various carbon filters because the quality of water which comes to our tap is not assured but it can be assured through synchronizing and continuous programs on water quality, data collection, analysis.

Verification as well as reporting. Utility must be from time to time like the data on water being supplied is to be analysed in a good way, report and show, also verify the accuracy of data. In many cities we see that there is air quality index displayed. Likewise, water quality index should also be displayed in public water channels so that people become aware of the good quality of water is being supplied and can be consumed directly.

In this way building trust is important and this can only be achieved when utilities go through stepwise as synchronizing, data collection program, monitoring, purification as well as reporting involving stakeholders to build the trust. For assessing the quality of supplied

water, intensive monitoring programs are needed and the idea is to show the consumers that water supplied to consumers is perfectly safe.

In order to make water perfectly safe, we need water treatment. The appropriate degree of water treatment must be provided and ensured so that the water quality functions as desired. The quality of water produced after treatment meets the standard and to keep monitoring, displaying so that people become aware of water is perfectly safe for drinking. The treatment plays a very crucial role here.

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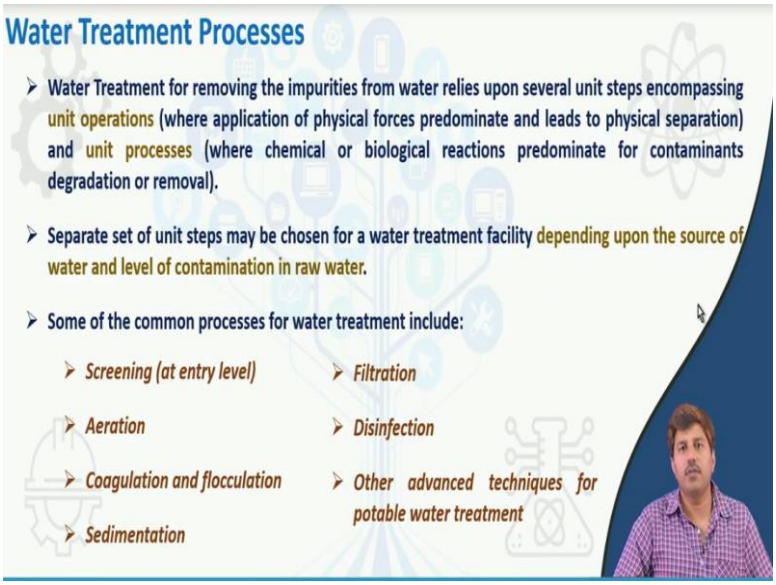

The step which converts water to the level of usage through monitoring, displaying modes can be made through public domain so that people will have assurance of water being supplied is of good or usable quality. If talking about water treatment processes we have been saying that removal of contaminants from water and how to treat water. Water treatment objective is of removal of impurities.

There is no single step or unit which can remove almost all impurities. There are high systems like RO and distillations can remove impurities but they are very high energy intensives which are not used on raw water directly. Then how do we go about treatment? We do have multiple types of contaminants present in water as discussed in the earlier session of water quality parameters like suspended solids which is be removed by settling, there are colloids which is removed by coagulation, flocculation or settling.

Also, there are microbial impurities which cannot be settled these needs separate unit for disinfection. Usually basic water system is a combination of several units which encompasses the overall scheme of water treatment which has multiple units is designed and used for the purpose of water treatment. Combinations can have two types of units – unit operations and unit processes.

Unit Operations basically relies on physical separation where physical forces are predominant like settling. We have large particles; particles of specific gravity greater than density water, settles down in the water. We have to allow some time. By the gravity or mass or physical weight, settle downs in water. This process is known as Unit Operation. Whereas the other type in Unit Process, chemical or biological reactions are predominant.

If something needs to be removed which is in dissolved state or converting it to precipitation state which needs chemical reactions, unit processes are needed. They are used in (speech not clear 27:39 – 27:42) unit processes of combination can give the good degree of treatment. Generally there are different units available for specific kind of treatment as discussing earlier, RO removes wide variety of contaminants,

Settling process removes sediments, colloidal require coagulation, flocculation process which also removes some absorbents, removal through high end processes. There is more than one option available and it depends on the designer to choose, economy, reliability available options. Separate set of unit steps may be chosen for overall water facility and it largely depends on the source of water, level of contamination in raw water.

Depending on the source of water, we have different types of unit structures for water treatment plant. Surface water source, water treatment structure or the sequence of water unit in surface water might be different than that of ground water sources. Some of the common sources for water treatment are Screening, Coagulation, Aeration, Sedimentation, Filtration, Disinfection and various advanced treatment process. We will talk about these processes in more detail.

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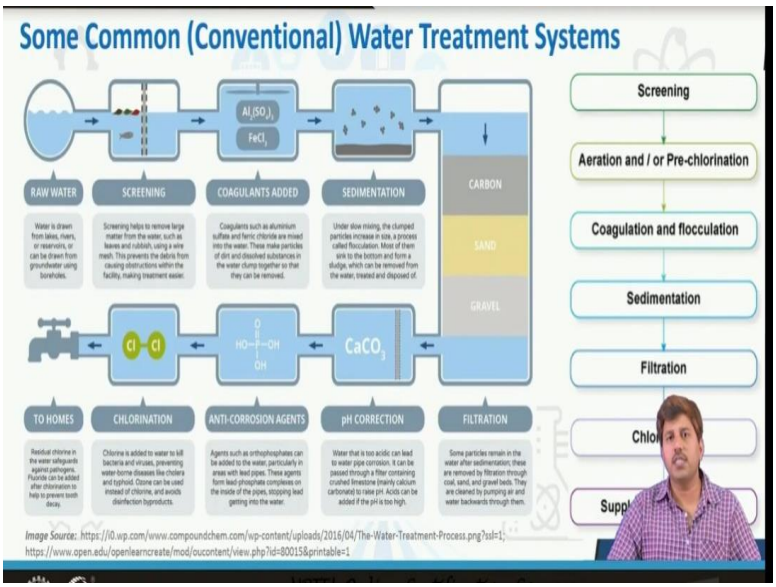

We see some common conventional water treatment systems. Generally Screening – done at intake level WTP (water treatment plant) level, we may go for pre-chlorination or aeration, coagulation or flocculation, sedimentation, filtration, chlorination steps can be taken. Surface water sources, raw water comes through first screening then directly for coagulation in a rapid system then settling, filtration may go for pH correction.

We should go for chlorination not essentially, but disinfection, after disinfection water is supplied. If you see typical layouts for conventional water treatment systems for surface and ground water. In surface water is collected from the source and screens, we have a rapid mix where coagulant is added if colloidal present will flock in flocculation then sedimentation process comes to filtration and disinfection is added to supply to the consumer.

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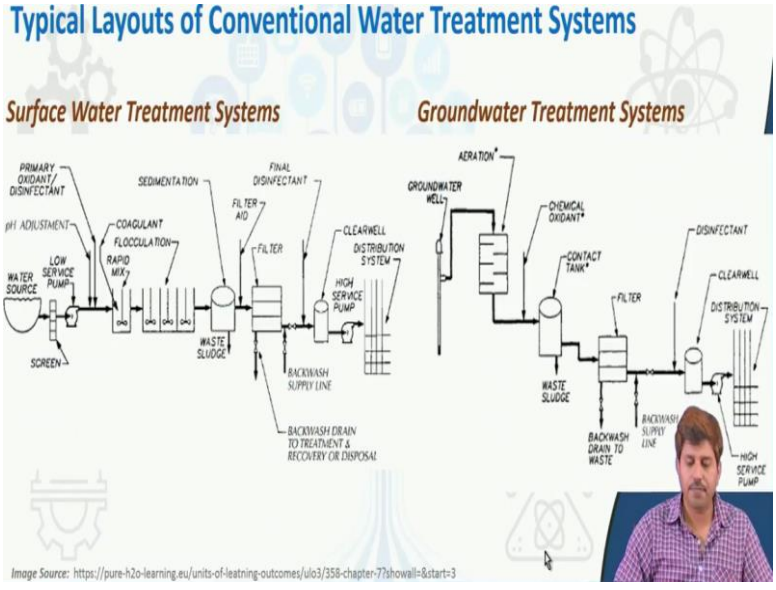

For surface water treatment we use conventional water treatment systems and for ground water sources we have additional variation. We may have or may not have variation also in surface water system depending upon the level of contamination and type of existing air content of water but for groundwater generally aeration is recommended but at times, aeration is avoided for ground water treatment system.

Some chemical oxidant may be added to the contact tank and flocculation process then settling, next filtration is done then the rest process remains the same like adding disinfectant and supplying water to consumers. These are the couple of layouts for treatment facilities sourced for treatment of surface water and ground water systems. Of course these are not hard and fast they can be changed and will be discussing these points later.

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These are a couple of pictorial views of water treatment plant. One is in Pune and the other in Jardine. This is how it looks onset treatment facility. We will conclude here and in next class we will discuss about specific treatment steps or units one by one.

Thank you for joining and see you in the next class!