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Lecture-25
Water Treatment Units: Screening and Aeration

Hello friends, so, we have been discussing about some of the aspects related to the water quality and in the previous lecture we did talk about why we need to treat water and what are the water quality standards that we need to meet and that basically calls for treatment of water. We did discuss the basic concept of the water treatment, which basically is source dependent could be a source dependent process as well okay.

And we listed some common units for the water treatment. So, from this lecture onwards, remaining basically lecture of this week and for the entire next week also we will be discussing these units for the treatment of water. So, what in this particular lecture we are going to discuss about the screening and aeration which are very preliminary units for water treatment.

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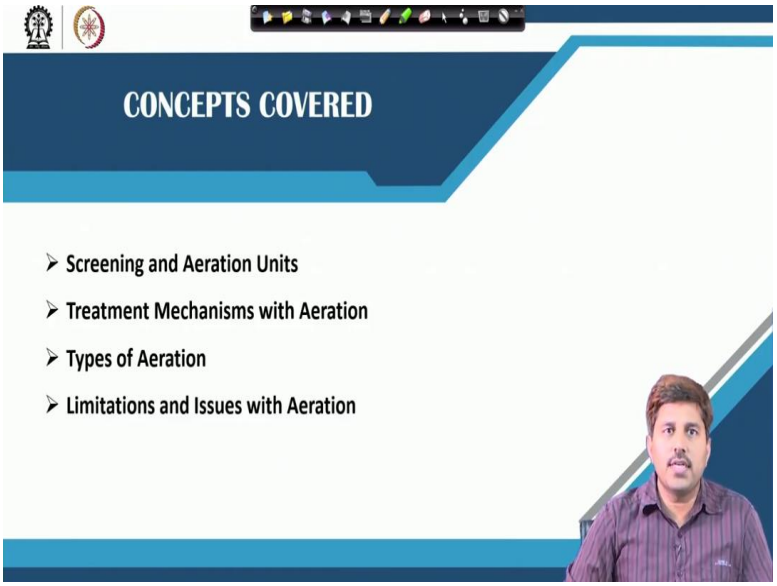

So eventually what we are going to cover is the what are the roles of the Screening and Aeration unit and with more focus on the Aeration what is the treatment mechanism with

Aeration what is the type, what are the different types of Aeration and limitations and issues with the Aeration process.

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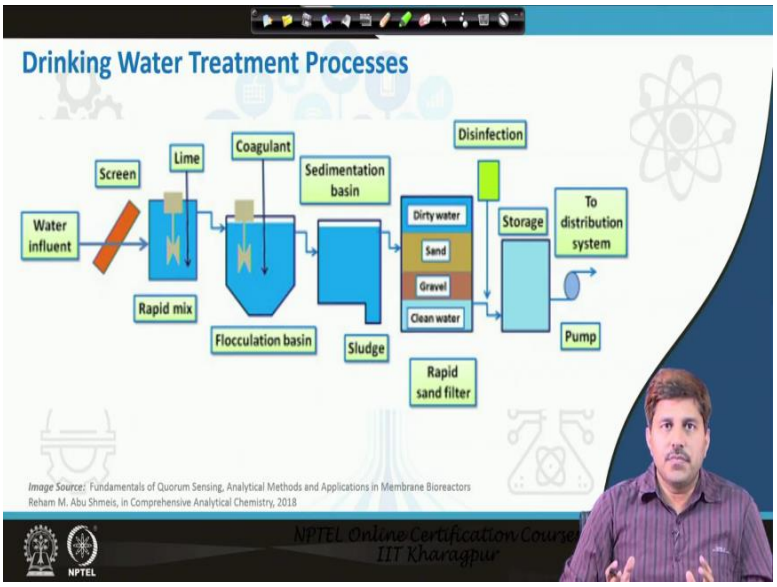

So, if we again look backdrinking water treatment processes, although it is a source dependent, but say for a typical water source from a surface water, so we get the Water Influent, so water from the source and then it is screened through a mesh or what we call a Screening process and in it then it goes to a rapid mix then it goes to a Flocculation Basin then Sedimentation, Rapid Sand Filter, Disinfection and then disposed off.

So, we will be talking about these processes later on, but what we are going to start the discussion is about the preliminary processes over here. Now, the screening.

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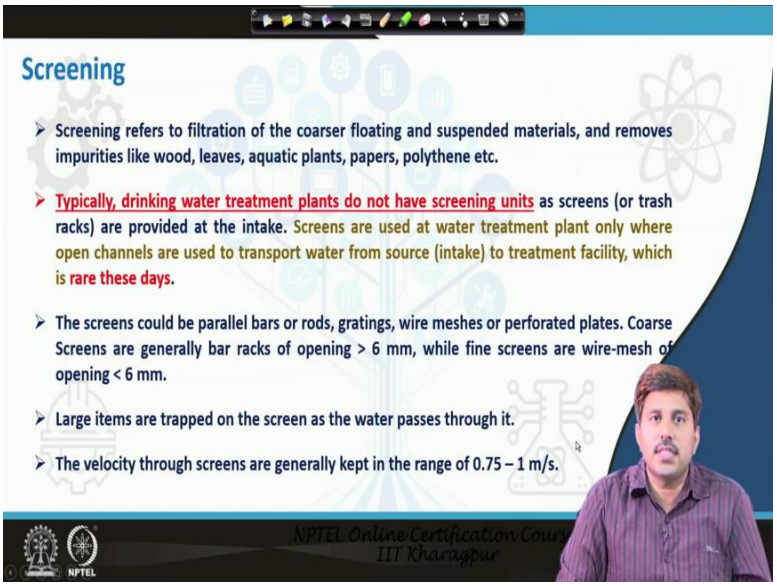

Is generally the first step which refers to the filtration of coarser floating and suspended materials. So, the larger materials like we may have papers coming in the water wood, leaves, aquatic plants then polyethene, these kind of things may come floating with the water and then they needs to be filtered out so that it does not enter into the our main basin or through equipment and pump and do not spoil them.

Now, screening is rarely used at a treatment facility though we are studying about water treatment plant and saying or talking about the screening unit but the screening is very rarely used at a water treatment facility. Screening is a must step but it is usually done at the intake site itself. So, as we discussed also in the earlier week when we are discussing about the water intake.

So, when we abstract water from source itself, in order to prevent these things entering into our pipe systems, we put a certain type of mesh or kind of screen there so that it does not enter into our pipes and does not spoil. So, the water that we bring to the treatment facility is already free from these kinds of impurities and that is why we do not need a screening at the treatment plant site.

So typically drinking water treatment plants do not have a screening unit okay. As it is provided at the intake itself, we may provide in the form of mesh we may provide it in the form of trash racks as we discussed earlier. We do have screens at water treatment facility only when water is being transported from the intake point to the treatment facility in the open channels, but that is practically very rare these days.

We do not use open channels for transporting water open channels are used for waste water flow. So, having a screen at wastewater treatment facilities a must but generally water treatment facilities does not have screen at the treatment side. Screens generally could be paralleled bar or rod or grating or wire-mesh Okay, or we can use even the perforated plates,the coarse screens generally,are bar racks where the opening is more than 6 mm, while fine screens are wire-mesh of opening less than 6 mm.

There are micro screens also available but they are very rarely used. These large items will be trapped in the screens if we are having a screen at the treatment facility or even at the intake

also okay and the velocity through these screens is just really keptpoint 0.75 to 1 meter per second range.

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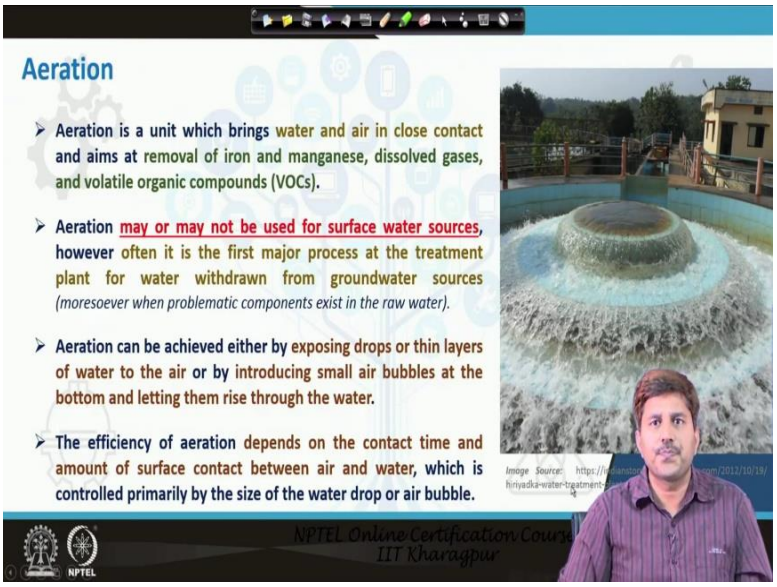

Now, the other unit is the Aeration, this is also a preliminary unit and it is basically unit which is more important for water abstracted from groundwater sources. So, if you are withdrawing water from the aquifer, the aquifer usually is in the subsurface and devoid of any oxygen transfer facilities. So, these waters have very low dissolved oxygen and that is the reason that they may contain certain impurities which could easily be removed by the dissolved oxygen okay.

The surface water sources may already be exposed to the dissolved oxygen, okay, because they are opening the surface. So, they may already be having adequate amount of the oxygen dissolved in it and majority of the impurities which could be removed by the aeration may already have been removed at the source itself may not be there in the water when we are bringing water to the treatment facility. So, we may or may not use the Aeration process for surface water sources.

Still we may use if there are impurities of that type present which could be removed by the Aeration, we may go for Aeration even for the surface water sources, but often we may avoid Aeration when we are abstracting water from surface water sources. However, it is usually the first major step at the treatment planfor water withdrawn from the groundwater sources. And more over, these waters have problematic component which could be removed by the Aeration.

Now what kind of component could be removed by the Aeration, the Aeration can remove the dissolved iron and manganese, it can oxidize them and then precipitate them. It can remove the dissolved gases like CO2 like H2S those kinds of gases can actually be removed, it canalso remove the volatile organic compounds. So, these are the few things which it can remove, it can be achieved either like we expose the drops or thin layer of water to the air or we introduce small air bubbles at the bottom and let them rise through the water.

So, these are the two approaches in one approach we put water, we basically pass water through the air and another approach we pass air through the water. Okay so, in either way we try to enhance the contact between air and water so that oxygen level in the water could enhance by facilitating transfer of oxygen from the air water interface from air to the water. The efficiency will depend on the contact time.

So, for how much time we are keeping air and water in the contact and what is the surface area available between air and water okay. So, that is what basically will be controlling and these are generally governed by the size of water drops or air bubble what we are creating in the system.

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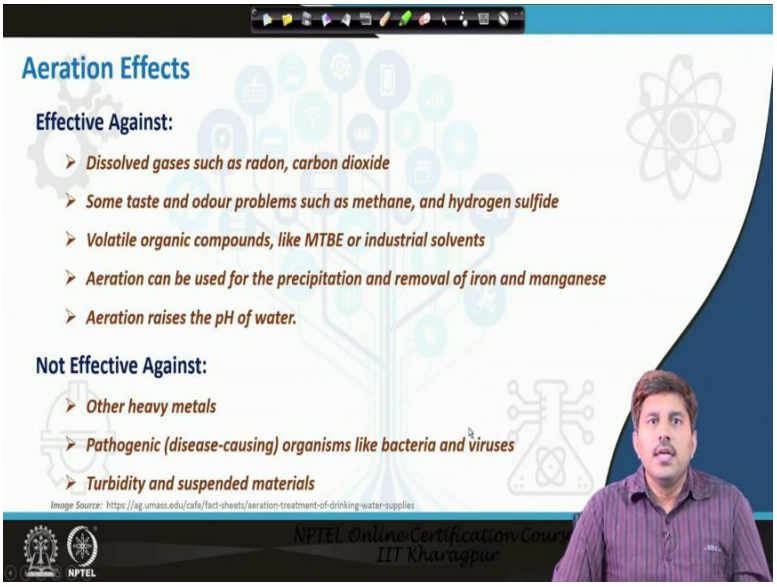

Now, Aeration is usually effective against several pollutants, as just discussed the dissolved gases like radon carbon dioxide, some taste and odour producing compounds like methane hydrogen sulphide, the volatile organic compounds like MTB or industrial solvents, it can also raise the pH of water and it can be used for precipitation and removal of iron and manganese and Aeration one of the major roles of Aeration in the groundwater is the removal

of iron and manganese. So, this is very prime kind of objective of Aeration when we go for groundwater systems.

Aeration is usually not effective against other heavy metals it does not affect them much okay, it can change the oxidation state, but they still mostly remain in the dissolved state, it is not effective against pathogens okay. So, the disease-causing organisms like bacteria and virus rather they may get more oxygen and they may get like they may proliferate more or so, rapid growth with Aeration, and it is not effective against the turbidity and other suspended materials.

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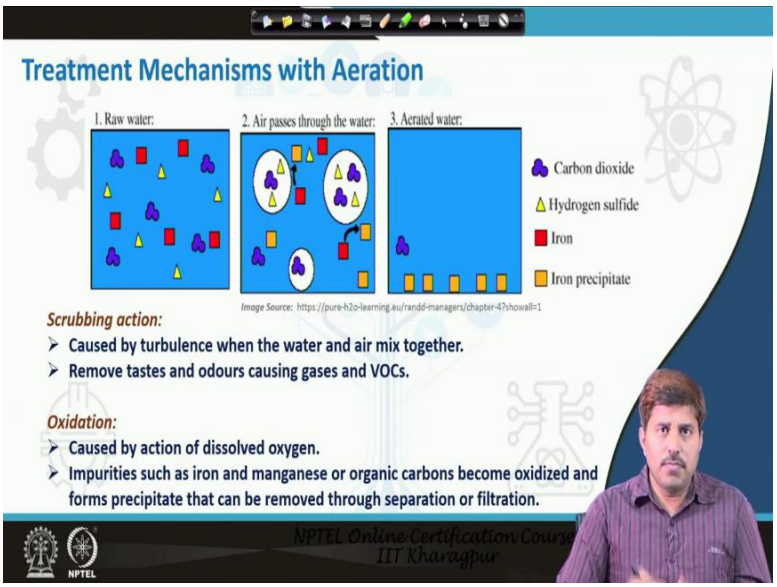

So, these are basically some of the things on which Aeration can work and some other on which Aeration is not effective against. So, if we see the mechanismhow mechanism of the removal of the contaminants through Aeration. So, generally there are two major actions, which helps in removal of the contaminants. One is the scrubbing action, which is because of the turbulence when water and air mix together.

So, this removes taste, odours and which is practically caused by the gases and VOC's. Scrubbing action is simply like when we are putting air and water into the contact more and more oxygen is coming into the water. So, it passes through the other through scrubbing action or through other like whatever is the dissolved gases it changes the pH those gases the dissolved gases may also come into the gaseous phase and escape the system along with the extra oxygen and when the partial pressure of oxygen is increased again some of the dissolved gases may come into the surface.

So that way like if you see the example over here. So, see these red blocks are of iron and these are the carbon dioxide side and hydrogen sulphide gases. So, when oxygen is passed, so, these things can be trapped in here in the air phase and can leave the system through scrubbing action. The other is the oxidation which is effective on the iron and manganese kind of things.

So, it caused by the action of dissolvedoxygen. So, when we have when we add more oxygen into this it oxidizes iron and manganese to higher oxidation states and as a result, they precipitate okay. So, like iron will, ferrous will convert to ferric and it will actually kind of precipitate as ferric hydroxide and these kinds of things which are heavier and then they settle out and the aquifers,

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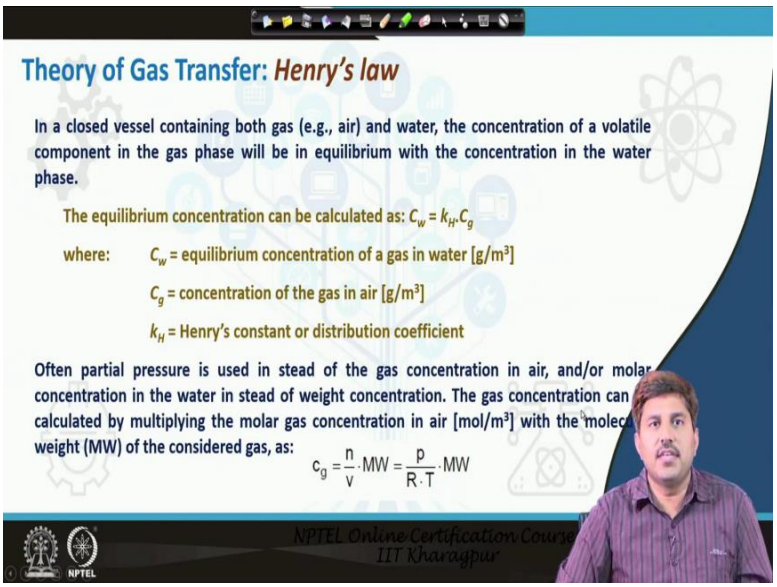

Will get free from these contaminants. How thegas is transferred, it basically follows Henry's law, okay. So, in a closed vessel containing both gas and air or basically water whatever we are talking about. So, either we have air, water or gas, water and then concentration of a volatile component in gas phase will be in equilibrium with the concentration in the water phase okay.

And that equilibrium is given by the C w is K H time C g where the Cg is a concentration in water and C g is the concentration in the gas okay or in the air. It is often partial pressure which basically is used instead of gas concentration because concentration in, estimating concentration of gas in the air is difficult. So, generally we will for the partial pressure estimation okay. And in what are we can go for molar concentration okay instead of the

weight concentration. So, practically we can use this equation where C g is basically number of moles divided by volume into the molecular weight. So, this way we can estimate the partial pressure in thegas.

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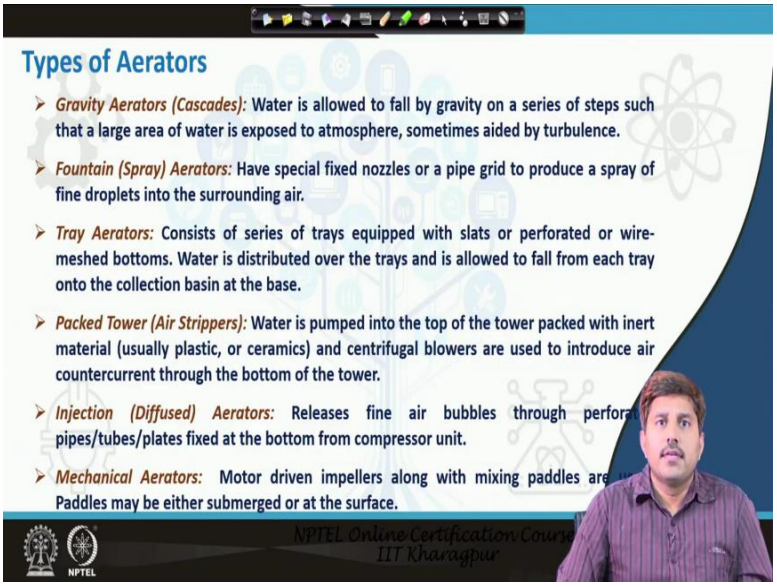

Now there are different type of Aerators. There are Gravity Aerators, Fountain Aerators, Tray, Packed Aerators, Injection Aerators, Mechanical Aerators. So, they vary on the different principles. The Gravity Aerators or cascades are simple aeration devices where basically water is allowed to fall by the gravity on a series of steps. Okay, so we will have let us say, we will have a series of steps and water is falling from here then basically it falls from here then it comes here.

So, as water falls in a thin layer or in the drops, it basically the contact with the air is enhanced, and this requires a lot of oxygen as it exposed to the oxygen and it is basically added turbulence also helps in getting more oxygen. The Fountain or Spray Aerators is the system where basically we have kind of water body and we can put a foundation and this basically sprays the water.

I am sure all of you must have seen these kinds of systems okay, fountains. So, this in the water in the small drops is a spread and then bigger it goes into the air and provides large contact area surface area and as a result when the water comes back it is high it is quite reaching the dissolved oxygen. Then there are Tray Aerators which consists a series of tray equipments. So, it will be like we have one tray over the other tray or the other tray and then

there will be perforation so water falls from one tray to the other tray and in this process, it basically requires the oxygen.It again falls drop by drop wise.

They are our Packed Tower or what we call Air Strippers as well. So,AirStrippers will be like we have long columns okay which are packed with some inheritmaterial.Generally, plastic or ceramics kind of materials can be used. Now, what we do we release water from the tops of water flows down by the gravity and we pump air from the bottom okay.

So, air flows, air will rise up and water will come down and in the in between they will interact and as a result the con the water which will be collected at the bottom will have the higher level of the dissolved oxygen. Then there are Injection or Diffused Aerators which areagainif we have say a tank, in the tank we place a pipe grid system in the bottom and these grid systems will have diffusers.

So, they will basically release the bubbles from the air from the bottom and air has a tendency to rise up in the in the tank. So, air will basically we moved up and it basically since it travels through the water so it provides ample opportunity for water to acquire more of the dissolved oxygen, okay so these are called Injection or Diffused Aerators. And then there are Mechanical Aerators.

Mechanical Aerators will have paddles, okay. So, say in a tank, it is it will be having paddles and it will be rotated. So, when they when basically rotates, it puts water into the contact of air and because of added turbulence,

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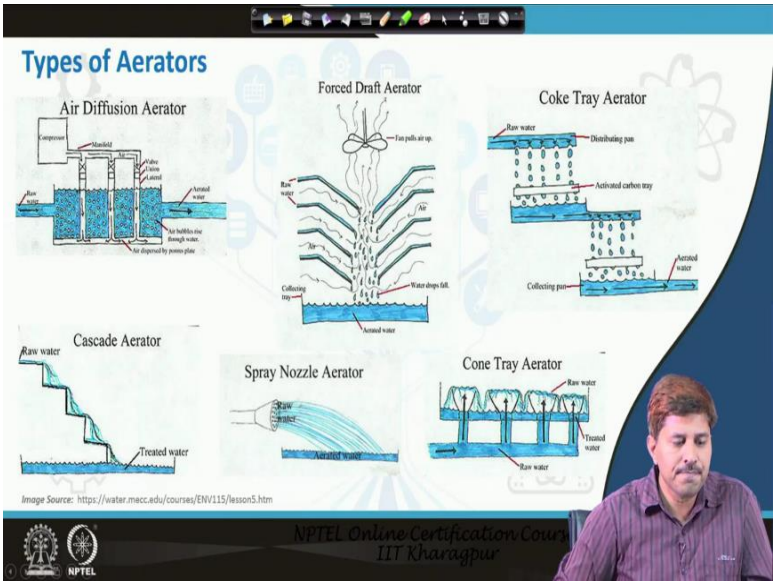

It kind of enhances the dissolved oxygen level in the water. So, these are some of the example as we were just discussing, this is the air diffusion Aerators. So, we have a pipe system and then from bottom the air is diffused, we have the Forced Draft Aerator. So, here we have a suction pump so, it basically sucks Air and Air will pass through this where the water is also basically flowing.

So, in this process it will acquire this. There is a Coke Tray radiator which is basically a simple Tray Aerator kind of thing. So, we have water passing through the drop by drop through this distribution pans, okay and finally it will be collected. Spray Nozzle Aerators we have spray nozzle or the system that is Spray Aerators as we were just discussing that it could be a Cone TrayAerator.

So, this is also many people would have seen over here. So, we have systems and then water flows through these cone kind of things and it falls at the water so that the dissolved oxygen level increases and Cascade Aerator is one very popular and very common Aerator particularly for water supply system because of its like it operates gravity and does not need mechanical power and other than pumping.

So, we may need to pump water from up to here and then basically it will be basically falling by the gravity and in the process, it will acquire the oxygen.

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These are some of the real picture so for say this is example of Gravity Aerator or Cascades. So, you can see how water is falling step from different steps. This is a Mechanical Aerators who has paddle and then kind of rotating those paddles will create the turbulence and will put put water into the air. This is the Injection or Diffused Aerator.

So, we have a pipeline system like this and from here the gas bubbles are released which will basically spread all over the water and as a result enhance the concentration of the dissolved oxygen in the water. This is a Fountain Tray Aerator, so Fountain Aeratoror Spray Aerator as just we were discussing so will have a fountain kind of thing through a nozzle, small nozzle it will be pushed through.

These are Tray Aerator or so water will passing through air. And there is a Packed Tower or Air Stripper. So, in water will be flowing from the top and gas will be pumped from the bottom and in between they interact and the oxygen level in the water is enhanced. So, with the enhanced oxygen level in the water, we can kind of get an advantage in terms of the removal of the contaminants selected contaminants as we discussed earlier.

Now, the different type of Aerators have different efficiencies, there are different distinct advantages and disadvantages like Packed Tower and if you try to remove iron and manganese through the Packed Tower, so, because it is a Packed Tower, so, iron and manganese will precipitate and they will kind of they will clog the system. So, you will see what either water flow is stopped or air flow has stopped.

So, it will actually be not a good system, like packed towers are not a good system for all of iron and manganese. Iron and manganese could easily be removed, say using the Cascade Aerator or in the tank where basically, even the Diffused Aerator is not a good option because those precipitate with settle at the bottom and may clogged the diffusers. So, we can go for Spray Aerator or Cascade Aerator or those kind of thing for them all of these for removal of VOC's.

The Packed Tower is very efficient okay it can remove even on the 99% of the VCO's, because it provides it when the water coming through the pores and same pores are being used for passage of the oxygens it provides very adequate contact and while air going up it can carry on the VOC's and other kind of gases along with it. So, each has their own advantages and limitations.

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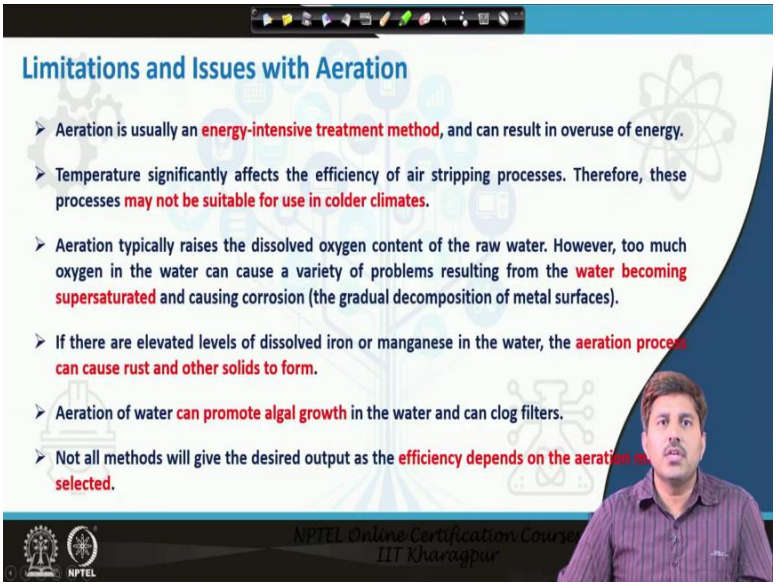

Overall also Aeration process, as I said that is not provided always, one of the reasons is that it is a quite energy intensive treatment process. We have to put the compressed air in whatever system we are providing or if we are, say using the Cascade Aerators, then also we have to pump the water to a level from where it can fall. So, because of the energy intensive nature, it can result in overuse of energy and that is why they should be provided only when there is a strong case for providing Aeration.

So, temperature also significantly affects the efficiency of the air steeping process. So, may not be suitable to use in quite colder climates. There are certain other issues like it can raise the dissolved oxygen content of the water. So, too much of oxygen can cause a variety of

problems resulting like water can become super saturated and can cause the corrosion as well. Okay. So, those kinds of things might also create problem in a long run.

Further if like high iron and magnesium there so Aeration process can cause the rust because the precipitates will settle, will form the solids and if we do not have adequate removal or cleaning mechanism of the precipitate, they can basically from huge amount of means huge amount of settlement can be there in the tank itself or they can rust the other mechanical equipments and other things also because of the resting nature of the iron precipitates.

Further it can promote the algal growth as I said it can promote the algal growth or even the bacterial growth in the water if we are using filter and those things it can basically clog the filters by algae, those kinds of issues might also be there. Further not all as just we are discussing not all the Aeration methods will give the desired output some have their like suitability in specific cases or the removal of his specific contaminants and the efficiency will depend on the what kind of aeration method we are selecting.

So, that way the different Aeration system we may have, we have to wisely choose whether first thing we need to choose is whether we want to provide Aeration or not. If there is a strong case for providing Aeration then only, we should go for Aeration okay otherwise like if we are abstracting water from surface water sources which is already having adequate amount of dissolved oxygen in that why go for unnecessarily Aeration.

So, Aeration may not be provided in the surface water sources, non water has relatively much stronger case, but that also is recommended only when there are problematic components present in there. If not, then we can even Wide Aeration for the groundwater sources maybe some pH control and those kinds of thing it can use. Second thing is there are chemical alternatives also available for Aeration, chemical or other alternatives.

So, if we are not providing Aeration and there are like there are certain things still there, So, we can take care of those pollutants in the later stage in the kind of advanced treatment stage or polishing treatment stage. So, that also needs to be seen that whether there is any advantage of putting Aeration at the initial stage or we can take tackle or take care of, if there are just few pollutants or some specific pollutants are the concentrations are not that high, they can be taken care at the advanced stage as well.

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So, that is about the Aeration. So, we conclude this lecture here and in the next class will be discussing about the next unit which is far more common than the Aeration and Screening is the Sedimentation Basins. So, see you in the next class. Thank you for joining.