Fundamentals of Environmental Pollution and Control
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Lecture No. # 15
Wastewater Treatment

Okay, good morning, I mean with what we have learnt so far that is about the water pollutants and you know the typical BOD modeling then you know is about this ground water modeling and ground water pollution. One very important thing by now you have seen that you know there is a, there are many ways water can get polluted either in the surface or in the ground water and now it's our turn to learn about the treatment of wastewater. Wastewater treatment becomes a very important area of a, very important area of environmental engineering. We will see in this classes about 6, 7 classes that I would take on this you know you will try to understand. You will understand you know how this wastewater treatment is designed, what are those priorities, what are the typical methods that we generally follow in wastewater treatment.

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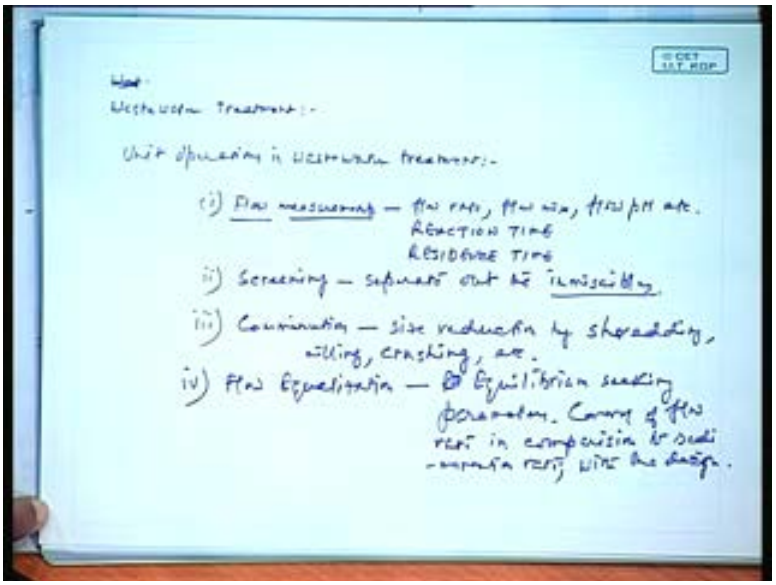

Having to say that you know let us bring out you know the stages you know the parameters of interest for wastewater treatment. See this, this is unit operations, unit operations, unit operations in wastewater treatment, right. The unit operations to start is any kind of, whenever there we are discussing with water anything regarding water, you also would understand that there would be a flow, there would be always flow and the measurement of flow is a very important part, you know this is remaining is the measurements, flow measurements, flow measurements where you try to deal most of the things that you would know try to find out is flow rate, flow rate, flow mix. What are the material that we have in the flow mixture, what would be the material that is more as important for this flow mixture, flow mix. Then we should have, we should have this you know about the flow other things about the flow pH, all these aspects has to be seen in great detail.

This is what is etc, would see this, these are the flow measurements that is a start with. Any kind of wastewater treatment method begins with the measurements I mean what are this then finally you know there is a reaction time, reaction time. What are the reaction times? Generally for this reaction, residence time, residence time is the time when a pollutant or a reactant would remain within the container, I mean this is the total time that is required residence time, reaction time then other rates you know the flocculation rates, all these the flow measurements becoming measurements I mean how this, all these you know where we have said those things but you know here itself is you can see that in terms of liter per minute or liter per second flow mix it be, what would be the solid, liquid, gaseous faces inside the flow, flow pH all these things comes to be very important.

These are the flow, flow of unit operations that we generally start with. The second one, most another very important part is this you know is a screening. Screening is one important part in wastewater treatment where we generally try to separate out, separate out the immiscibles, immiscibles those which cannot be mixed with the water. There will be something you know, and you can know says there are, there are to be understood in this fashion. One is which is not at all dissolvable in water, there are many things like you know which you know that they are not dissolvable in water at all and there are few things which are dissolvable but as such anything which has dissolvable in water is also dissolvable to a saturation limit. So, till that saturation point it would remain dissolved above than that more than that it would not be dissolved state.

So, you know you just like if you continue to mix salt in water, the salt would be dissolved till a certain point that is the saturation at that temperature, pressure in water okay. So, after that the salt would come out of the solution, salt would be generally either remain deposited at the end of the glass or would remain suspended as the case may be. So, this is what is this is separating of the immiscibles. The screening is a very important part of, I'll also talk about I will give you flow diagram where you will be able to understand this but this are the unit operations that we generally try to do or carry out comminution, comminution. The word comminution you must have come across in blasting say the blasting is what is basically comminution means size reduction, size reduction say by different methods by shredding, by shredding, by shredding, by crushing, by crushing, by shredding, by etc by different means that we generally mills or another willing crushing etc. So, you can see this comminution in the size reduction by shredding and materials like that you know it has a great importance. As such what is the importance of comminution mostly? In one great important part of comminution is there as soon as you break something, the surface area increases.

The surface area has a great role to play. The surface area is you know it increases that the rate of reaction, it exposes more area available for reactions. So, this comminution essentially does that, so you know this is what is very important part. In many cases when in, if you just shred it a substance say you know something like you know a bag, you know a leather bag in water. If you just you know if you just keep it like that and if you just shred it, I mean completely cut into pieces and then put in the water, the bio degradation time of the shredded parts should be taking lesser time than the larger one, as simple as that because the largest surface area exposure. So, this is comminution, this is comminution is a very important part. This is, the next is the flow equalization, flow equalization, this is you know flow equalization is that you know is about equilibrium, equilibrium seeking parameters, equilibrium seeking parameters.

So, I mean say you know flow equalization would be something like wherever you know that you know the control of, control of flow rate and control of flow rate and in comparison to, in comparison to, in comparison to control of flow rate, in comparison to control of flow rate, in comparison to say sedimentation rate, sedimentation, sedimentation rate in comparison to control of flow rate in sedimentary rate. Then you know other you know designed parameters combining equilibrium seeking parameters with design, with the design, with the design. Say if you are a, is a very important part of experimentation. In an experiment part you know wherever you are trying to design or experiment with something, one very important thing is that that you know you must design for a perfect say a type of flow rate, a time that would be associated with the different reactant should be in connect, in contact with each other.

Then you have to the flow rate has to be matched then you have to, you have to be the flocculation, the flocculates or whatever would be deposited removal of that at a particular periodic intervals. These times the intervals when actually how much time take it takes measurement of that and to form an equilibrium. So that whatever is the input, the input and output are balanced is, it should not be nothing like that you are putting more input you are not getting that amount of an output. So, there would be a process somewhere in a process getting stuck somewhere. So, this kind of situation is whenever we are trying to balance these kinds of situation, we generally talk about flow equilibration. So, this say is flow equalization that is what we generally talk about, this flow equalization or something there are, there are called equilibration is another term where there is an equilibrium such sort, process equilibrium.

Equilibrium means input and output are matched; this is what is the condition of equilibrium. In situation like as you know in an perfect situation you know in a different, different types of the reactions in the water environment, say if you are choosing for a particular reactions to take place say you know at a particular pH certain deposition has to takes place you are aiming at that. So, the equilibrium would be at that page what would be the rate of flow, so that the equilibrium is reached. So, the input and the output there is a proper matching, this is what is important you know in most of any kind of flow, a flow kind of situation this particular parameter is of great important, importance. So, you know there is another important aspect you know which you should also deal with is that you know is a mixing.

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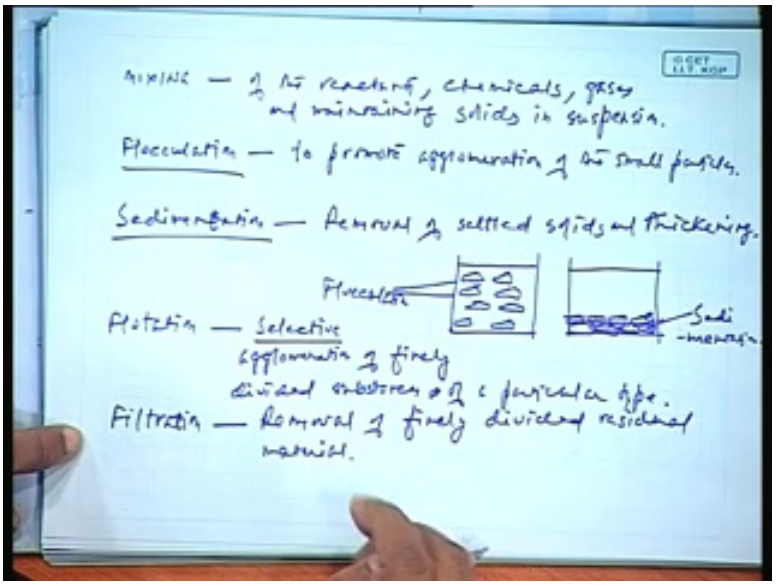

Mixing, say mixing this mostly say the mixing of the reactants, mixing of the reactants you know this is of, it is also of great importance in the sense that you know in many cases in a design there is a risk, always there is a risk in the flow that you would not be getting the designed rate of output, designed rate of output say you know the reaction mixing is something like say if you are sending these are the typical things that take place say know if you are, you are using lime in the water, so in such cases when you are using lime in the water or you if you are adding alum in water what happens is, if you are, if the water has a relatively high velocity, so the alum and the water would not come in mix.

The alum would not find enough opportunity to meet with the reactants of, so alum say the lime would not find enough opportunity to meet with the reactants that it is designed to react with. Is it clear? I mean so this kind of situation takes places, the mixing of the reactants is a very important part, so that the larger part of the body, body of water say you now if you have mixing tank if you have a mixing tank in the situation like this, you will find that you know a top column is not being mixed, the bottom column is only getting mixed, so that would how to make a homogeneous mix of the, in the total column. This is what is the mixing parameters, these are the situations where we would like to know about more about the mixing.

So, here if the mixing of the reactants you know the mixing of the chemicals, reactants, chemicals, gases, gases, etc you know which are maintaining and maintaining, maintaining and maintaining the solids in suspension, solids in suspension, maintaining solids in suspension this is what is the mixing part flocculation. Flocculation is one great important, this is a flocculation to promote, promote agglomeration of the small particles, agglomeration of the small particles. Have you ever seen, I mean see now if they you would understand this agglomeration, the process of agglomeration is the use of alum in water. Have you ever seen what is the, how this alum reacts in water. Next time if you go you know go home or anywhere try to see what alum does. Just a piece, a pick a small piece of alum, drop it into a picture in a or in a container of full of raw water and just see what it does, it just leave it for some time yeah.

Yeah it would, it would clot the all particles. What it is actually doing is agglomerating the particles. So, one aspect of alum is use agglomerating small particles together. So, what happen is as the result of that, as a result of that the mass actually increases. So, as soon as the mass increases, it would be once it's gets agglomerated if the mass itself the, as the density increases so as a result of which you know it begins to settle or remains suspended at one point and so that they are also visible at that way you know they become visible also. Even a small particles in solution there may not be visible but when they are agglomerating, it becomes more visible you came to know what are the parts to be removed.

So, this is what is a agglomeration of this flocculants or the flocculation is a very important part of wastewater engineering. Sedimentation say one of sedimentation, the sedimentation is the removal of, removal of settled particles, removal of settled particles, settled solid, settled solids and thickening and thickening, sedimentation removal of settled solids and thickening. So, you know you have to first of all after you have flocculate, you have done the flocculation but if it is, if it remains suspended at in the body of the water like you know if you see in a pump or in a container like this you would expect that this particles, this flocculants after the flocculants have generated, you would find the particles suspended like this. Irrespective of this you know sedimentation process you would generally try to see that this particular in the body of this water, these particulate settle at the bottom. So, there it becomes easier for you to remove that.

It becomes time to time periodically you can remove the settled particles. And this is, this is the place you know where agglomeration is taking place, this is the flocculation. Either by the flocculated product this is what is sedimentation. So, in a here you can see that the difference. These are sedimentation, this is what is, this is what is desirable. In a plant you try to have say the material being sedimented, this only then when they are sedimented it is easier for us to remove them, is important for us to have to have a situation where we can remove the material. The next is you know the flotation is a, flotation is another, another you know this a froth flotation in the selective, this is a selective, selective agglomeration of selective agglomeration, selective agglomeration of selective agglomeration of finely divided substances, finely divided substances and substances of a particular type, selective agglomeration of finely divided substances of particular type.

If you remember this flotation is what happens in the flotation chamber is doesn't matter you know whether it would in a flotation chamber you know in all cases it would generally try to attach something, some of the particles a selective particles like you know if you remember this if you know in a mining process is very common in mining and concentration process, froth flotation. What we generally do in the froth flotation? We generally use a particular say organic, a metallic organic substance say sodium xanthate or potassium xanthate that we use, this sodium xanthate and potassium xanthate you know particularly in a copper concentration process, it would only agglomerate with the copper particles and bring it up in the surface, bring it up in the surface, this is the flotation part. So, you know here it would be another very important part is selective agglomeration because you know you don't require to take everything up, you would only try to take a very typical particle that you want to bring that up and want to remove them for different purposes. In froth flotation copper you know this, this particle or may be this particular substances, it may be in due to say that removal of dirt or collection of a particular element say in rich in copper of this kind of things you know you would use that froth flotation.

So, you know here also you can see the flotation is being also very important part, filtration is another filtration, filtration you know where it is the fine filtration is removal of fine residual of finely, finely divided, finely divided, finely divided residual material, removal of finely divided residual material. This is what is the procedure of filtration. We have to filter out or actually we have seen you know mostly say you won't, you won't like that in the flocculated material or the sedimented material to remain in the flow, you would have to separate them out. And how to do that? this is one is the filtration is one method by which we do know generally do it. There is another aspect you know this today's you know this is filtration in microfiltration or micro screening.

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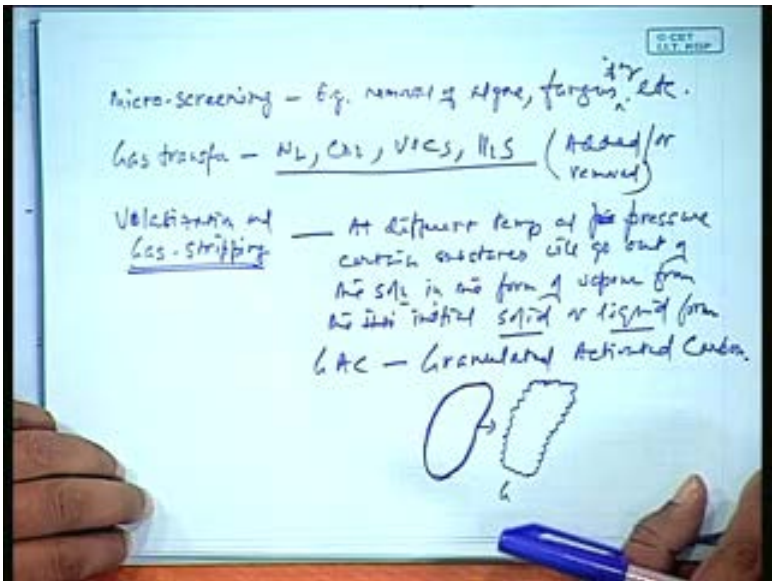

Micro screening is say an example for, an example is removal of algae, removal of algae or any other substances you know algae kind of a mostly the algae and say fungus also etc, if it is, if they are present if any. So, this is about micro screening. Gas transfer, there would be you know during the process of reactions, reactants you know there would be a number of gases would be produced gases like nitrogen, a gases like carbon dioxide say this particularly you know then the several organic VOCs, a large quantity of VOCs are produced, H 2 S is produced. So, this you can see, this needs to be, this gas transfer, this gas to be generally has to be removed sometimes it has to be added, added or added or removed. Addition is also required, this is the gas transfer you know sometime the gas transfer this addition is required just for to initiate a sudden reaction, to initiate a sudden reaction gas transfer may be needed.

So, otherwise you know in a chamber if you just see you will try to see you know say activated sludge process or any other process you see you will produce lot of gases also, that gases also have to be removed from time to time, periodically that has to be removed. So, otherwise this can be of dangerous consequences you know the gases can do you know is particularly if it is a closed process, if there is a huge buildup of gas it can be extremely dangerous also. So, time to time thus the gas has to be removed, the degassing or this gas transfer is taking place you know another is volatilization, volatilization and gas stripping, volatilization and gas stripping. You

know you see, here you can see there will be at, there are some substances like you know some substances which at particular temperature pressure would be, would be volatile.

Generally in STP mostly you know standard temperature pressure, we know those of substances which are kept out in the open they would, they would volatile, they would be vapourized but there would be some situation where if you increase the temperature, a substance from either from the liquid or from the solid may go into a gaseous phase that is also the volatilization and gas stripping. Gas stripping is taking place particularly with the use of say you know volatilization as you say, as I have said at a different temperature and pressure, at different temperature and pressure certain, certain substances will go out, certain substances will go out of the solution, will go out of the solution in the form of vapour from the initial, initial solid or liquid form. The form of vapour from the initial solid or liquid form say the liquid form say now you can see this solid and liquid form is a camphor. As you know camphor is a substance, if you heat camphor you know it does not go into a liquid phase, it immediately goes to into vapour phase. So, is something like that there will be many substances in liquid, so liquefied nitrogen gas, liquefied oxygen whenever they are released in the standard temperature pressure they become volatile.

So, these are thus gas striping is also takes in place, here is a gas striping is a case where particularly a number of you know say there are substances like you know say granulated activated carbon GAC we call them the granulated, granulated activated carbon. This granulated activated carbon this is called granulated activated carbon, granulated activated carbon. What is this aspect of this granulated activated carbon? The basically the difference if you just see coal and you know it's basically coal and coke that we see, the coking, the process of coking by which the coke is produced. What is the difference? The essential basic difference is the number of surface areas are more, the surface area is more, not number total surface area is more.

Suppose, if there is a substance like this if say there is a substance like this, this as a regular surface, regular surface very you know very plain, very smooth surface like this but at the other hand if this surface can be made to be like this where there are you are increasing the surface area, you are increasing the surface area and as a result of that you know particularly when you are increasing here and here you see this is the granulated part, this is a granulated and activated. We call it this activated because these surfaces, these surfaces are very good to keep the gas absorbed in those openings or in those holes or openings that they create.

So, is across the body that is the difference between coal and charcoal. What you see in a coal and a charcoal is basically the coal would be having lesser surface area, for the same mass the coal would have a lesser surface area than charcoal or for that matter coke also. As a result of what happens is as this surface area increases, within this surface area, within this surface area number of gases can be absorbed like one of this you know you say one of the area this is most of this water that you can see you know in your water filtration plant that you see in your hostels or anywhere, there is one chamber which is basically full of granulated activated carbon is most basically charcoal, treated charcoal, treated and you know sized charcoal. It's not a large sized charcoal, as the size increases the surface area further increases. So, you know the size charcoal, this charcoal is through which the water is generally passed. What happens is the bad odour, the odour that you generally have in a bad smell in the water that can be removed. See, even after

treatment the water might contain some of the say the substances which are, which can generate bad odour or bad say smells.

So, this odours can be the odorous gases can be absorbed by this activated carbon surfaces. This is what is the volatilization and gas stripping, we generally used this gas stripping in various industrial wastewater treatment methods, okay. Charcoal is also in used in that we… right, yes. Yes. So this is the charcoal, the use is the granulated activated, the only, the difference is the surface area is not saturated. the surface area is you know highly exposed surface area and this surface area under at a particular pressure, under a pressure condition can absorb a number of gases mostly the odourous gases as a result of which the water becomes much more acceptable okay, the water would be much more acceptable as such, so this is what is reason required for the gas stripping. So, these are the processes that we generally deal, the processes and parameters that we deal in wastewater engineering, it's okay.

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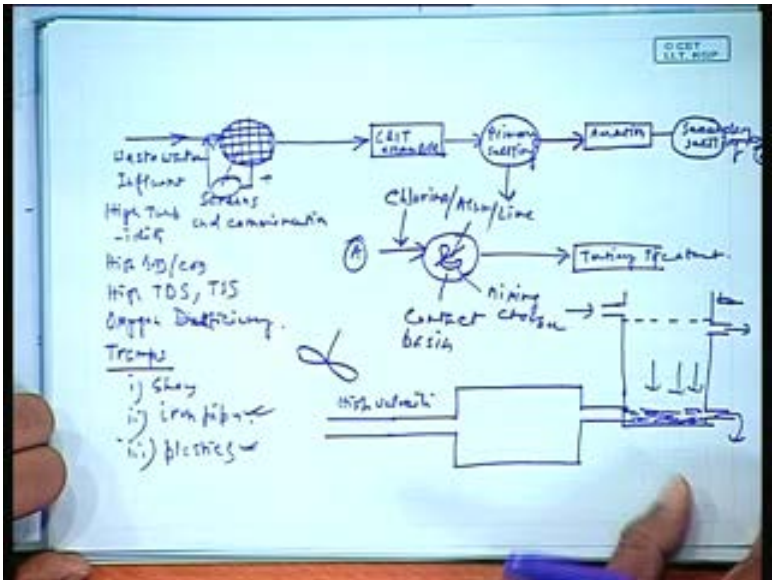

Having gone from this let us, let us try to see you know how this what are the methods of wastewater engineering that we the typical classification methods and the typical process that we generally observe. Here, you can see this now is that you know in many cases like this if you just see now wastewater influent let us make a process first, wastewater influent. This is water is getting inside into the system, the screens there would be screens and this is screens, screens and screens and comminution. This is where there would be screened, there would be screened and they would be, they would be laid by a process like this, this is screening and comminution.

We will find a great chamber then we will find a grit chamber, grit chamber. This in the grit chamber we generally try to separate out this, the most of the foul materials, most of the foul. So, I will come back to this. grit chamber, after the grit chamber you find that you know if you generally call this as a primary settling, primary settling, primary settling, primary settling. In a process of this primary settling we can find out this you know primary settling will see this here

we will use a loop here, let me come back to that you know later on. So, this is what is called a aeration process, aeration tank. This is aeration, aeration then comes the secondary settling.

Primary settling we have seen then we see secondary settling, we have secondary settling. After the secondary settling we generally use after this you know if you just see this secondary settling now this secondary settling here continued say A, here A continued, so here can see this secondary settling, we generally use chlorine. Chlorine is chlorinated substance, chlorine can be used any kind of chlorine you know in the form of bleaching powder or whatever you generally use, we can use alum, we can use say lime all these substances that can be used here. Then this is what is, this is what is they would be added here chlorine contact here, this is, this contact basin, contact basin, contact basin. This chlorine here is a contact basin in this chlorine or whatever we generally try to do, this would be actually you say that the drawing would be somewhat like this is you just correct this drawing, this is like this, okay.

I think I made a mistake here. So, you know you say this is a mixing chamber, this is to say this is a mixing, mix in a mixing chamber, mixing chamber then we go out for, go for mixing chamber. This is what is the primary settling then the mixing chamber then it will go for the secondary. This is primary, this is primary settling, aeration secondary settling, after this is the, this is called okay this is called then we go for tertiary treatment then we go for tertiary treatment. So, you know here this is called the tertiary treatment. So, you can see this you know this is the process let me explain you fast. What is happening here is wastewater, with this wastewater remember a standard wastewater I mean any water that is coming from different sources, water coming from different sources to the plant.

What we expect, what we get in the water? Say, you know water is you know basically high turbidity, high turbidity, high BOD, high BOD it might or you know high BOD, high COD or high TDS, high TSS. All though it will have so this is, these depend upon the characterization of the water, water, what are the water has, what are the things the water has. If it is a particularly say sewage wastewater you may not, this is will find mostly the high BOD and high COD. As I have said in mostly say oxygen another very important thing is you know oxygen deficient, oxygen deficiency, oxygen deficiency, this would be deficient in oxygen. Mostly all this wastewater would be deficient in oxygen apart from that, apart from that there will be some gang materials say this we generally called a tramps, tramps. This tramps are say a shoe, a number of shoes then say this say iron pipes, iron pipes then you will find say plastic.

Plastic is another very important thing plastics, so you know you can find this is what is in the influent, if you just see the character of the influent. So, what we do in the screening? In the part of the screening and comminution, if in the part of the screening and comminution what we are trying to do is we are just trying to separate out in the screens itself. A screens and wherever required you are breaking them so that in a large part of that in small pieces it passes through the screen, okay. So, you can see this you know in the screen also, in the screen whatever is available in the screen, whatever is the exercise, the plus size that we can see, the plus from the screen would go through a comminution process, would go through a comminution process, would go through a comminution process and would be again referred back to the stream, you would be again referred back to the stream of water, okay. So, this can be seen like this but this, what you do with the iron pipes or plastics or things like that. All iron pipes they would be

broken? No, they would be just separated down, they would be just taken out, there would be some other implements you know by which this material would be taken out from the body of the water.

So, here you see the water that we generally observe here is itself we are just trying to find out here is in a, if it is, if this is a flow is like this you know a flow is a high velocity flow, high velocity, high velocity flow, this high velocity flow going through this screens and finally when it is coming to a grit chamber in the form of a grit chamber, it would be this generally large and wide. The reason being is as a result of which you know this the kinetic energy of the water, the kinetic energy of the water would be convert into potential energy. As the potential energy increases, the velocity decreases.

So, the velocity decreases means you know settling increases. Essentially, we have to settle those things, particles we have to settle. When they are in a, in a, flowing in a particular above the critical velocity they would remain in the suspension. So, as soon as you reduce the velocity what would happen? They would begin to settle down. So, this is what is the grit chamber. In the grit chamber whatever has passed through the screens would be first allowed to settle, would be allowed to settle and this settled in a grit chamber. So in a grit chamber, if you just observe a grit chamber, a typical grit chamber, if it is an open grit chamber it would be like this where you can find out say this one is you know here you would find out in an open grit chamber like this where a large part of this would be… in a grit chamber what would be happening is, so this is how the water is being for, this is the level to be maintained as you can see this water coming down.

So, here the level is maintained. So, here the particles which should be settling here, the particles that would be settling here would be taken out, okay. So, the settled you try to understand this, this is what is, this is what is coming from the screen, from the screen with lot of TSS, TDS it also has, TDS you cannot do much at this level. What we are trying to handle this, at this time is TSS, the more total suspended solid, all kind of suspended material. This suspended material as this velocity reduces, so we can find a large amount of, large body of particles, large body of material would begin to settle at the bottom. Isn't it? Would settle at the bottom.

As they settle at the bottom, as they settle at the bottom, the water would be more clarified on the top, water would be much more clear on the top and this water would then be taken out, okay. See, till this time, till this time we have not, we have not seen, we have not seen any kind of, any kind of say any kind of reactants being added to the water. We have not used added anything so far, we are just trying to physically remove things from the water. So, this is also there would be a followed by a grit chamber, there may be another primary settling time where even smaller particles would be allowed to settle okay even smaller particles would be allowed to settle then we would add, then would be, this is what is the aeration. Then the next stage is aeration.

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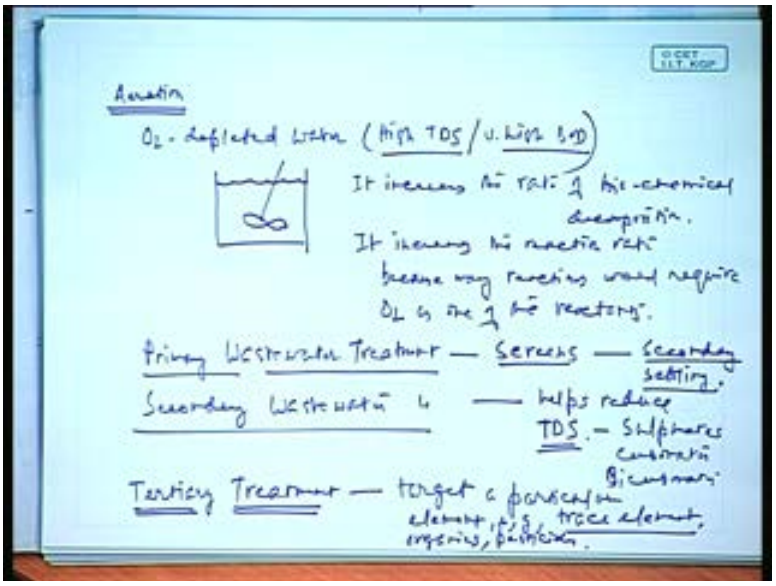

What we do in aeration? The aeration has a great importance. Let me explain little bit about aeration here. this aeration has a great role to play. In most cases you know all this kind of reactions you know if you are, if this particularly this in the oxygen, oxygen, oxygen depleted water, water, this can result due to high, very high, very high TDS and very high, very high, very high BOD right in both the cases that the water may be substantially depleted, okay. You remember, you remember that plot I have shown you that you know that increase salinity, the oxygen concentration decreases. So, this is what is the increased concentration, increased dissolved concentration of a equivalence salinity would actually reduce the oxygen in water, the level of oxygen in water. Oxygen also be reduced by this BOD also, biochemical oxygen demand, the oxygen that would be used for decomposition of the substances.

So this cause this oxygen depleted water, this oxygen depleted water would be aerated, they would be, they what would be done, what would be done, they would be you know the stirred, they would be is a typical methods of aeration is you know typical method of aeration were would be say the mixing, this is one of them is a stirring operation that we generally do the stirring, a large of stirring that we do. Say this surface aeration also can take place, we generally allow it to come in contact with the air around it. So, as a result of this, this is you know here it is how it helps. It helps significantly, it's helps significantly because you know it increases, it increases the rate of, rate of biochemical decomposition.

If it increases the rate of biochemical decomposition, it also increases, it also increases the reaction rate, reaction rate because many reactions in water would require many, it increase the reaction rate because many reactions would require oxygen as one of the reactants, as reactions would require oxygen as one of the reactants. I'll show you some example where you would find that the oxygen is a necessary part, not only, not only for biochemical degradation but it is also required for chemical precipitation purposes where oxygen is required, oxygen has to be added, so this aeration actually helps that.

The next part is comes is the secondary settling. After this, this kind of, after this one is added there is may be another secondary settling chamber, another secondary settling chamber. A secondary settling chamber in such cases would be here where there would be, there would be again another, another settling would takes place. Till this time, till this part we generally known as is till this time is known as primary treatment. So, till this time of secondary treatment, secondary settling we generally talk this as the primary wastewater treatment, primary wastewater treatment that is say from the screens, screens to screens to secondary settling, settling.

In many cases, in many cases you know many places like you know very many places like even in places like IIT Kharagpur also, even the typical wastewater treatment method if they are not using, if they are not using any substances at the treatment method say basically till this much only primary wastewater treatment. What you are generally trying to do is most of the cases, we are not adding anything, we are just allowing the natural reactions to take place, we are trying to facilitate the natural reactions, the substances that are within the water that they are reacting with each other and finally settling. So, this is what is called the primary wastewater treatment. Then comes the secondary wastewater treatment, secondary wastewater treatment where we are adding something.

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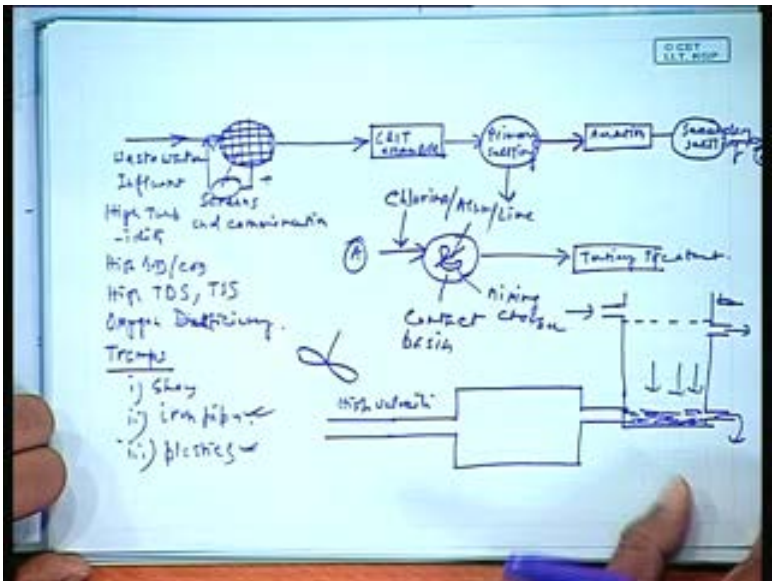

Here you can see this in the last part as you can observe here that I have said here that this one where is the chlorine is being added, chlorine, alum or lime being added with the water. This is what is called the, this is what is called this you know the secondary treatment. This is the start of the secondary treatment in water, this is the start of the secondary treatment in water. Now, what happens here is that much of, much of this part here, much of this part if you can observe now the secondary wastewater is this helps reduce, the idea is to reduce, helps reduce, helps reduce what, helps reduce mostly the TDS.

It generally the TDS mostly say the fixation of the sulphates, sulphates then carbonates bicarbonates, bicarbonates and say the sulphides you can think of all kind of substances, the radicals that are possible. So, you know here we are just trying to address to the situation where we would try to bring down the concentration of this substances or in the either in the form of a radical or in the form of a element, okay. So, here this is what is generally we are trying to see here. In the final part here at this in the method of treatment here is the tertiary treatment, tertiary treatment. The tertiary treatment target, target, tertiary treatment target a particular, target, a target, tertiary treatment target a particular, particular element say, say a trace element, say a trace element, trace element which may be, which may not be removed by this secondary, primary and secondary wastewater treatment. This can only be removed by may be using a tertiary treatment method.

So, bulk material, bulk pollutants in water say iron, zinc mostly iron, zinc say sometimes you can say a copper then say something like copper, aluminum all this these bulk substances would be removed from the wastewater stream by the secondary wastewater treatment. But for tertiary treatment you know suppose we are targeting a particular pollutant in water say mercury, say chromium, say cadmium or say even say arsenic. Whenever we are trying to do that we have to adopt a specialized technique you know which we should be added at the end of this tertiary at the end of the method but this has you can see this tertiary treatment method are expensive and so mostly most of the wastewater stops at, most of the wastewater treatment stops at the secondary wastewater treatment.

In our country whatever you are seeing that wastewater treatment is taking place, most of the wastewater treatment stops at the secondary wastewater treatment method. The tertiary treatment method is being expensive and being you know being generally a much more difficult to control, so as a result of which most of the people generally most of the places, the governments also would not do the tertiary treatment but the case is it is much more necessary nowadays, it is much more necessary nowadays because we are finding a number of pollutants in water which are so, which are so I mean which are so resistive to the standard treatments like say primary and secondary wastewater treatment that they can only be treated in the wasted, tertiary wastewater treatment method. So, otherwise this can be say you know trace elements say then the organics pesticides, organics, pesticides very right pesticides, all these pesticides all these require tertiary treatment. They cannot be removed by this primary and secondary wastewater treatment up to a, below the threshold, below the threshold. So, this is what is all important, all right. I mean I am coming back to this class again I mean this for this class this till this, this time, this part is completed, okay.

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So, we would be dealing with this primary waste wastewater treatment techniques that we would start now.

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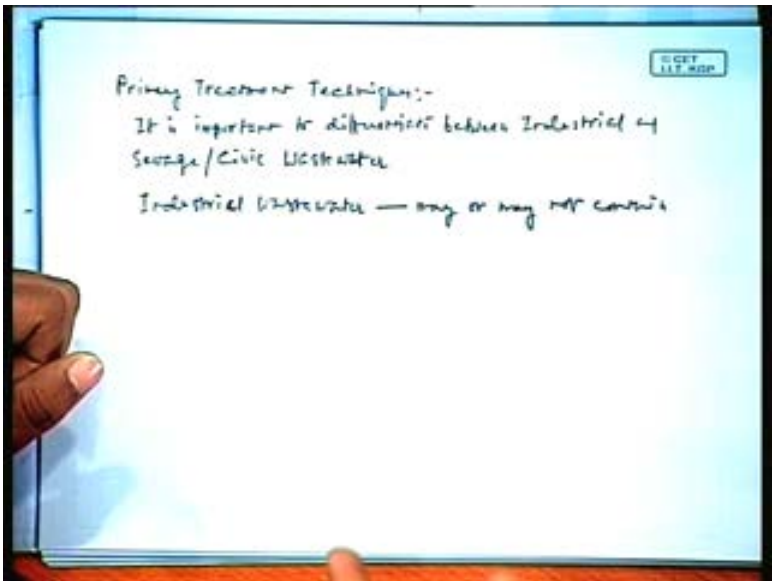

But before that let me tell you, you know we would not generally discuss much about the screening and filtration part because you know this is the very basic part I have said but this is, there has the method of screening, screening, method of comminution that I will not discuss mostly but we will start with the primary treatment techniques. At this junction you know it's pretty important for all of us to understand that difference between the, what is the expectation about the water.

Suppose, this water is coming out from a source, any source say coming out from an industry, coming out from a sewage pump coming out from a typical say a process like you know something like food processing waste. What are the expectations of the water? I mean having seen the water or coming out of a particular industry or a process, we should try to understand what we should expect in that water. Say, in a food processing wastewater would have high BOD, essentially it would have high BOD but it will have less say inorganic TDS, less inorganic TDS may have some salt may have in the lessed inorganic TDS.

So, here but on the other hand say a mine waste, mining related wastewater or say wastewater where there are only the substances, the mixing substance are of inorganic nature we would only observe inorganic salts present in that. So, in the most of this mining wastewater acid mine drainage or whatever we discuss about will deal with that also, acid mine drainage and all this. We generally observe the water to be of a certain characteristics. The characteristics is initially whenever it is, whenever, wherever it is getting produced there would be the environment would be oxygen deficient, this is number one.

The second point that we would observe in such cases is there would be no, very little BOD because mining as such the process does not create any place for BOD to be produced. So, why we would find is this would be high TSS, high TDS but this high TDS whose basically due to inorganic content, inorganic contents of different kinds of metal, cations and anions, okay.

Only one thing still today much of this can be achieved a great amount of water filtration can be achieved if this kind of small typical very simple systems are very effectively used. I can tell you with all I mean all my understanding about the subject is the earthen filter that we used to see you know, you know in our childhood you know even say in my childhood specially say you know in cases like that they are as effective as many of the water mechanical or electronic filters that we have observe today, they are equally effective.

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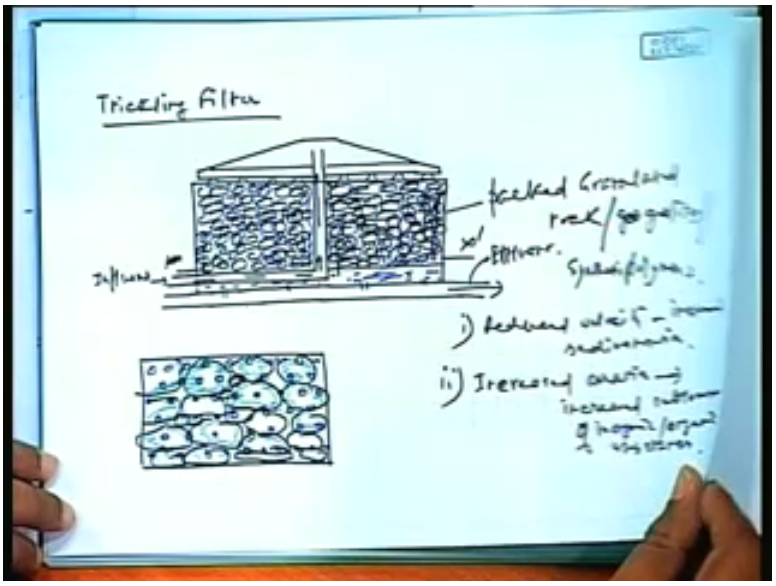

Only most important thing is that has to be maintained. You don't expect that that this would be set up for in countries like ours. The problem is we set up a plant and then forget about, we generally do not make much effort to maintain it. If we maintain it, this can itself serve a lot of great purposes, they can be as effective as secondary treatment methods. So, here this is about a trickling filter, there is another very important part is you know is that is generally is called is a rotating biological contactor, rotating biological contactor, rotating biological contactor.

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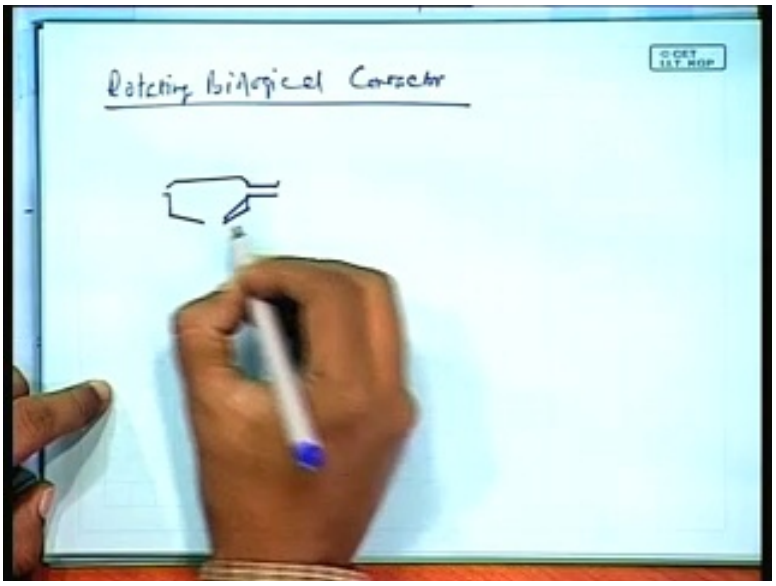

Let me make a drawing first, this is how it looks like. You will find this you know in the text book also you know you will find this drawing here but try to do the drawing I mean I'll, I'll make some changes in the drawing okay. It should be, it should be like this and then this, okay.