

Water Quality Management Practices

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Week-03

Lecture - 11

Wastewater Treatment Classification and Plant Analysis

Hello everyone, welcome everyone to this NPTEL online certification course on Water Quality Management Practices. My name is Gaurav, Professor Gourav Dhar Bhowmick. I am from the Department of Agriculture and Food Engineering of Indian Institute of Technology, Kharagpur. So, in this particular lecture ah it is a it is actually the first lecture of the module 3 ah where we will be discussing about the fundamentals of reactor engineering and the self purification of natural water. In this particular lecture video ah we will be discussing about ah more on details ah on the wastewater treatment classification and the plant analysis. The concept ah that I will be covering in this particular lecture are the wastewater treatment classification, what are the determining factors on it.

Ah classification of treatment methods, elements on the plant analysis and the design etcetera. So, to start with we know that when we go for the wastewater treatment procedures and all ah in a wastewater treatment plant or effluent treatment plant what we target? We target to keep our water pollutant free, to keep our water waste free like you know waste or the waste product or the pollutant or the ah foreign particle free isn't it. So, this degree of treatment when we talk about in a wastewater treatment it definitely account determined by comparing the influent characteristics first. I mean like the what are the wastewater characteristics of the influent like pH, TDS, TSS, BOD, COD, TKN etcetera etcetera.

And also we have to understand the required effluent characteristics, what should be the effluent characteristics that means, ah the water which is coming out of your plant. So, the water that will coming out of your plant will be considered as effluent. That effluent should have the characteristics I mean the water quality characteristics adhering to the regulations given by the local regulatory body or the controlling agencies. In India in the case of India we have central pollution control board, national green tribunal. So, these are the these are the authority authority or the authorization body ah authorizing body I

would say like who are actually taking care of the standards which actually has to be abide by ah the all the municipality or the industries or whatever like you know the target ah ah incorporation it is.

What are the factors in which ah this ah characteristics actually in ah rely on I would say? First is the physical factors, it involves the volume, the flow rate and the composition of the waste water. Definitely the volume plays a very important role because based on the size of based on the flow rate or the volume of the the the reactor the the plant ah the design that you have based on the ah the floor ah footprint based on the available land ah land footprint that that is available to you based on that you design your reactors the volume of your reactors that is available and that volume of your reactors will obviously, will determine will be a very deterministic factor because suppose flow rate will go up and down. So, based on that your ah detention time will also vary and suppose this detention time will vary that will drastically affect the the reaction rate is not it. So, all together this flow rate volumes those are all interrelated. At the same time the composition of the waste water that means, the the physical or the chemical impurities present in the waste water that also is a very important factor.

Then is the economic factor, it is not only because the technologies are available we can go ahead with that. If you would have been that case then all the countries all the cities in ah the most of the countries would have been installed already the mess this kind of sewage treatment units or say like ah effluent treatment units in case of industries why cannot they afford it. In some of the cases some of these technologies are actually putting some additional economic burden to the to those institutions to those ah municipality or the industries and because of that those economic burden will play a major role and because of that this economic factor is an major ah you know like you know factor or determining factor I would say ah which actually controls that the application of those plant design and its actual risk from this R and D unit I mean like say in the lab or in a research institution to the actual field. Next is the institutional factor definitely the you have to have a regulatory framework at the policies and the governance. If your ah government if your ah the policy makers if the regulatory framework ah designer I mean like the most of the ah regulatory control like you know controlling authority of your of your country are abiding by the rules on this given by the scientists or the researchers in that particular field and they actually put a very strict ah you know ah action on that then only it is possible.

So, if your regulatory body is not keen enough and to you know actually implement those ah important criteria's ah that has to be ah somehow abide by all the institutions then all this research all this ah development does not make any sense. So, the policy makers the government the institutions who are responsible for the preparing the standards and all

they have to be very much active they have to be very much ah proactive in this in this sense. So, institutions factors are also depending and frankly speaking like country to country it varies like anything because of the influence by the policy makers of the political or the ah government body like I mean like the regulatory body they are not they are not unable because of their ah the unexperienced ah governing ah body that is present that also makes the huge difference. Environmental factors definitely the all this plant design to treatment to execution all these things actually has a very good very much impact on the nearby ecosystem is not it. Suppose whenever you will be designing a new plant you will be installing a new plant in your vicinity.

So, it has its own ecosystem thriving before that. So, you completely destroying it and you are trying to develop a new facility that will kind of you know use it for treating the waste water and water and all these things ok, but anyway. So, when all this important all this important ah infrastructures are needed at the same times you have to be very much aware that how much you are actually demolishing the how much you are actually ah differing the actual ecosystem that is to be present there and how you can build a you know win to win situation for both of them that the ecosystem will also not be demolished completely. At the same time the treatments plant will also be useful for you know somehow ah that the replenishing the ecosystem nearby like how because of the say like the sludges that you are getting or say like waste water the final effluent that you are getting you are just simply part of it you can just simply ah irrigate like you know use it for irrigating the nearby areas for free of cost. So, that you know that nearby area can actually ah made with a very lushy green ah area and all and it will actually help to nearby ecosystem to thrive more easily.

It has to be a win-win situation for both of it. So, industry like you know the development should always ah be you know accompanied by the ah ecosystem ah nourishment then only it is considered as a sustainable development. What are the classification of the treatment methods? If you remember in last discussion last lecture also we have gone through a very brief manner that what are the ah types of ah you know processes I mean the types of units are involved in the ah system the treatment methods those are involved in the treatment units and all our treatment plant of this kind. Then we were discussing there are like two basic types unit operations and unit processes. What are these unit operations? If you remember we discussed that when we apply some physical forces to remove those pollutant we call it unit operations ok.

It is known like most of the cases we do it ah by say like screening, mixing, flocculation, sedimentation, flotation, filtration you know it better right. You see the what is happening in the filtration we are applying some pressure from the one side and because of the pressure that we apply the water will pass through it and there is a membrane there

is a porous membrane because of the porous membrane all the ah pollutant or the foreign particles will stay behind. So, this is how the applying of the physical pressure physical you what you are doing you are ah doing this filtration procedure. So, when you go for this sedimentation process sedimentation is nothing, but because of the forces due to the gravity what is happening the ah the larger size particles with the higher specific gravity will settle down. So, this is called the sedimentation process.

So, this comes under the category of unit operation. So, please remember that whenever we will be discussing about the unit operations not only in this sector, but in future also one will be researching on different aspects and all unit operations when we say it normally defines it normally you know denotes ah when we apply some kind of physical forces ok. Then there comes the unit processes. Unit processes can also be subdivided into two types sometimes another three types also possible like one is chemical, one is biological, sometimes biochemical process ok in in where we actually implement biological as well as the chemical processes. So, what are these chemical unit processes? You can you can easily ah get an idea about it.

Suppose the precipitation, adsorptions, the disinfections all these things what we are doing you are some applying some chemical agent or you somehow in in for enforce one chemical reaction to take place. So, that some separation or disintegration or some accumulation of ah event have accumulation events will happen. This is called the chemical unit processes like say like the adsorption. You are adding say like activated charcoal. How it works? When you add some activated charcoal what it does it has a active surface which actually helps the helps to adsorb some amount of say foreign particles some amount of pollutant to its surface.

So, because of that when it adsorb into the surface of external surface of ah this activated charcoal, it actually cleans the ah the water. This is the this process you are adding some chemical to clean the water to reduce the pollutant level. This is called the chemical unit process understand. Then there comes a biological unit process. What is biological unit process? Try to understand.

Then we add say like we have a some amount of organic matter present in your wastewater. So, we have a sugar solution simple sugar solution. When you keep it in you know you keep it open in a in your say like in your kitchen one sugar solution keep it open for some days it will see like an after a while it will become if you completely cover it will become smelly after a while. If you just ah do not cover it and try to you know like you know keep on rotating time to like keep on mixing it time to time and all you will see different kind of microorganism will start growing there. So, what is happening there in both the cases in first case when it is covered with a lead its anaerobic

condition will be prevailing there right.

There is no oxygen transfer from the atmosphere and once there is no oxygen transfer from the atmosphere there is a chance the anaerobic microorganism will start growing you understand. Once this anaerobic microorganism will start growing there they will consume this sugar you can there is a chance you will if you will check the COD BOD of ah the sample it will reduce with time. You remember we discussed how what is COD BOD it gives us an idea about the amount of organic matter it is a estimation of organic matter it is a passive way of doing it right. So, we can easily understand you will see the with time the this BOD COD value will drop down. That means, thus the sugar solution is being consumed by some kind of bacteria, but you will see with time there will be some accumulation on the on the bottom.

That means, what are those those are nothing, but those when the sugar solution is being consumed by those microorganisms they converted into what first to energy to continue with their ah bodily processes and the second is to their biomass. This biomass with time it will settle down on the one they will die it will settle down on the on the bottom of it. So, this way in anaerobic process we convert the organic matter into a more viable sources of easily ah available sources of you know I mean like you know reducing the ah waste. How this biomass can be easily collected from the bottom and then you can use it as this is nothing, but the sludge in a higher scale when we talk about you understand. Same time just to give you the idea how it looks like another case when we are keep on mixing it that that is a good solution we have a system by which we are actually keep on mixing it.

What will happen if we keep on mixing it? It will make the water airy enough I mean that means, the air exchange are quite frequent is not it. So, we make some ah turbulence what will happen we discuss we know about it right the diffusion the diffusion process will increase. So, what will happen if the diffusion process will enhance the air the air which is getting diffused from the atmosphere to the water will increase. If the air will be more the oxygen will also be more because obviously, the oxygen present in the air is almost 20 to 21 percent. So, that percentage will also be in a entering to the aqueous media which will be called dissolved oxygen.

So, once the dissolved oxygen is much higher or some somewhere like you know almost in saturation level or like you know quite a bit higher it will prevail a aerobic condition. In presence of aerobic condition say aerobic bacteria will start growing. This aerobic bacteria also loves to consume the sugar ok. So, in both the cases anaerobic and aerobic both the cases they are actually converting into some kind of gas and the biomass and those gas will be evaporate will be you know escape from the system and the biomass

can be easily collected. This is a very basic of the concept we call biological treatments very basic concept how we actually convert a waste to a biomass.

So, that that biomass can be easily collected and the waste can also be removed from the water. So, the water which will come out of this system is very much reduced in the quantity of those pollutant you understand. So, this is how the biological treatment process works. So, this biological treatment process this unit process biological unit process when we discuss this is nothing, but the this biological process that we discussed aerobic and anaerobic this comes under the biological unit processes ok. So, normally because of the biochemical activity of the organisms this biodegradable organized substance will convert into gaseous and the biomass.

So, this is this what are the example of it the bioremediation, oxidation, aeration, membrane bioreactors etcetera ok. So, I hope you understand what is this biological unit processes are called in some cases we have a biochemical processes also and this is like the mixture of chemical as well as the biological activity and where we sometimes add some chemical to enhance the biological activity and this adding this chemical to enhance the biological activity and so, that our main target to reduce the some component. Just to give you one example sometimes we add additional amount of iron in say like in a high huge water bodies say like to reduce the ocean acidification and all they add the huge amount of say iron substances. When the iron substances are there, there will be a chance of algal bloom. When the algal bloom will be there algae what it will do it will consume more amount of oxygen from the atmosphere and what it will do more amount of carbon dioxide from the atmosphere or the dissolved condition it will also release some oxygen ok.

Once what will happen because of this phenomena carbon dioxide production carbon dioxide will actually been you know like sequestrated carbon dioxide sequestration will happen you understand. So, this is how of one process you are helping. So, chemical you are adding, but biological process is actually enhancing. So, it is like a biochemical process that you are actually impose impose upon ok. So, this is how this is the biochemical unit processes processes are they look like ok.

I hope you understand this three different basic classification of treatment methods. So, what are the categories of treatment methods? To start with let us start with the primary treatment. How the primary treatment looks like? In primary treatment we normally use the physical unit operations in order to remove the floating matters and the settleable suspended solid from the waste water. Please remember whenever we will be discussing about the treatment plant we have three vertical basic three vertical. First thing is the primary treatment processes.

In primary treatment processes what we are doing we are trying to get rid of say to in order for you to visualize it say in the primary treatment we try to get rid of the bigger particles bigger sized foreign particles. Say we put a screen what will happen in the screen all say like you know this shampoo sachet or say like you know the bigger particle that the hair and all these things which goes into the waste water it will be separated that is the first unit. Second unit is the called secondary treatment ok then there comes the third unit. So, in general there are three units this primary secondary and the tertiary units ok. So, in case of primary unit we are trying to get rid of the floating and the settleable suspended solid.

In the secondary treatment is more of a you know biochemical unit process remember we discussed just now aerobic or anaerobic. Most of the secondary treatment processes we use some biological process in general and then after the biological process we try to sediment all the biomass and from the sediment we call it sediment in a sedimentation tank and we remove it from the system. Sometimes we have to add another treatment unit which we call tertiary treatment. Tertiary treatment can be a any one or the combination of two or all three physical unit operation and the chemical and the biological processes ok. So, why we do that we do it because to do some finer treatment to do some you know finer polishing I would say before you actually dispose it into the surface water body.

So, in case somehow some pollutant will escape through the primary treatment and the secondary treatment we can catch it in the tertiary treatment units. And then so that we can make sure that the final water which is coming final waste water which is I mean like the effluent which is coming out of your plant is almost maintaining the standard given by your countries regulatory bodies you understood. Then what are the different other elements of plant analysis design and what are the technologies which are normally you terminologies that we normally use. First of all is reactor we know about reactor right reactor refers to the vessel or the containment structure along with all its appertences. This this like it looks like a structure at which we normally go ahead with different reaction to like you know reaction to take place.

Like say in this case one example it is called this is one type of reactor. In this one reactor what is happening one vessel or the container where we add some bio media we call it the this you can see this multi agent phases this bio medias. In this bio media what is happening bio films are growing on a surface of it even inside of it. We are adding this bio media purposefully into this reactor into this vessel so that the biological different kind of aerobic or anaerobic microorganisms can grow on the surface of it. So, to increase the surface area we add this bio media this small you know this irregular

shaped structures this plastic beads it can be plastic or any ceramic or any other material.

Then we keep on aerating it if you are aerating that means, these are the aerobic bacteria that we are trying to trying to you know grow there perfect. So, we are supplying the if influent using this peristaltic pump peristaltic pump is you know either maintaining the constant flow and using the peristaltic pump we are actually supplying the waste water there. That waste water in the presence of this aeration and the this biofilm or the aerobic bacteria on the surface of it they will consume the organic matter and at the end from the top of it from the from the supernatant we can collect it as a as a effluent line. So, in that effluent line if you check it you will see there is a drastic difference between the COD, BOD and all the other organic I mean like the engine and the efficiency you can easily realize from this kind of reactor.

So, you understand this is called the reactor. Reactor is a place or the vessel or the container of where along with all is apotenusus we normally go ahead with some particular reaction to take place or the multiple of reaction multiple of those reactions. Then there comes a flow sheet. So, flow sheet is what it is the graphical representation of the of a particular orderly combination of unit operations and processes used in a treatment blend ok. We why we design it we design it in order to achieve a certain treatment standard. So, this standards are given by your regulatory bodies we try to add it to the standard and we try to maintain that ok.

So, when we start in the beginning if you see on the top left we have this primary treatment unit or the unit operations as I was discussing, secondary treatment units or the unit processes and then sometimes we treated effluent can be again treated in a tertiary treatment unit. So, here we normally design a conventional one which is which normally constituting only the primary and the say like secondary one. First raw sewage enters we have to design one screen we have to make sure the screen is means like you know whatever the we the screen particles we have to collect it either manually using a rack or there is a mechanical one also by which you can easily collect it and we can store it somewhere. Then there come the grid chamber in the grid chamber grid chamber we get rid of the grid particles majorly the with this the solid which is having a certain specific gravity we will discuss about it in future module we will be designing all these modules to be precise in future will be it is all of this. So, this grid chamber it will come out of we get rid of the grids then there comes a primary clarifiers.

In the primary clarifiers it further settles down the settleable solids and to reduce the to and we call it the primary sludge then it comes to the aerobic biological reactor it further reduces the organic content by biological activity. Then it goes to the secondary clarifier all this biomass remember we discussed when it goes to aerobic treatment or the

anaerobic treatment it convert into biomass then that biomass has to be collected how we can collect it we can have a clarifier simply we leave it we put the water there leave it for some time it will settle down from the bottom you make a hooper like structure or any other structure you collect it from the bottom this sludge as easy as that and that supernatant you let it free you let it go to the next stage of operation ok. In this stage we do this sludges can we we can simply put it in anaerobic digester to you know further digest the water to you know first of all we dewater it and then we put it in the digester. So, that we can go ahead with the further utilization of the the organic matter present in the present in the sludge and we can convert it into some valuable byproducts majorly the gaseous and all ok the biogaseous and all this biogas can be useful for different purposes and then digester sludge we can use it for different purposes like agriculture purposes it can be a very good soil amendment material you know.

So, this is what the flow sheet looks like. So, now if I ask you suppose I am a say suppose a normal resident or say like policy maker of your city I come to you or say like I am a municipality people from your city and I come to you and you being the engineer or say like the designer I will ask you. So, like sir please ah sir or ma'am please ah design me ah treatment unit of we we we we for this particular zone or the particular area ah I can show you I can give you the result of the water quality of the tree of the effluent of the wastewater or which is coming out of this city in the area of the city and coming we directly discharging it to the surface water body right now, but please design a treatment plant. So, once you are given this job what you want to do first thing you need to know all the water quality parameters like the influent characteristics as I was mentioning. So, you ask them to give you give you all details of the influent characteristics then you design it based on your idea that ok.

So, if the influent has this this parameter. So, I need to have this this one screen one grid chamber one ah say like aerobic biological unit then another anaerobic then say secondary clarifier or like this you can design it you based on the idea that will be developing for the next couple of weeks you can design it and then you can suggest that ok. So, as you have mentioned you need to design this is these things. So, while doing so, very first thing that you need to think about is the flow sheet how it will look like what are the different components which will be present there in your treatment plant ok. Process loading criteria that is also another very important thing that in general it gives you the idea about the you know basis of sizing of the individual unit operations and unit process and which will be which normally cause the process loading criteria or process design criteria normally it design it includes first thing is the the hydraulic loading rate what is hydraulic loading rate it is the amount of water each tank can handle. So, it is more like you know as easy as that suppose you have a small bucket ok, small bucket of 10 litre ok.

Say small bucket of 10 litre of volume and say like surface area of say just to give you some representative figure to make it easier say like 1 square meter ok. You have a 1 square meter of say 1 bucket or 1 small container 1 square meter of surface area. So, your flow rate which the water through which like you know at which actually it is coming into your system say 1 meter cube per day. So, if you have a 1 meter cube per day of flow rate divided by 1 square meter. So, what will be your process hydraulic loading rate 1 meter cube per day per square meter ok.

You understand? So, this is how it will look like. So, 1 meter cube per day per meter square is the unit unit hydraulic loading rate for your I mean like the it is a hydraulic loading rate of your design of your treatment plant. Then there comes the organic matter loading. Organic matter loading normally what happen it can be also identified as with two different nomenclature. First one is volumetric loading rate that means, with your flow with the inflow there are some BOD there are some organic matter entering to your system. What is the volume of that what is the volumetric loading of that I mean like what is the amount at which this BOD is coming into your system.

That is very important when you design a system right specially when you design a organic treatment unit I mean like the biological treatment unit in the secondary treatment unit secondary treatment systems if you remember. In the biological treatment unit you have to know it is very important for you to understand the volumetric loading rate as well as the organic loading rate as well, but let us start from the volumetric loading rate. So, how we can quantify it is very easy you need to understand the kg of BOD applied per unit volume of the reactor per day. What does that mean? You need to know the value of Q what is Q here if you see the volumetric loading Q is the flow rate. You need to know the flow rate the influent flow rate the pipe through which actually it is coming and it is coming into that your first treatment say like vessel or the reactor in your aerobic reactor or the anaerobic reactor you need to know in the pipe what is the flow.

You can simply put a flow meter with the flow meter you can see that what is the meter cube per second or meter cube per day of flow rate that you have ok. Next thing from there you can have a sample line from the sample you can just go and check the BOD of it that BOD is a representative BOD of the influent waste water is not it. So, once you know the BOD in milligram per liter say or milligram per liter can be converted into gram per meter cube milligram to gram is like you know 10 to the power minus 3 and again gram to liter to meter cube is also 10 to the power minus 3 you understand. So, this is how we can easily convert into milligram per liter into gram per meter cube numerator, denominator same. So, milligram per liter is equal to gram per meter cube if

you again multiplied by 10 to the power minus 8 will become kg per meter cube is not it the gram will become kg ok.

So, if you see this calculation the volumetric loading rate if you know the value of q which is in flow rate meter cube per day and the BOD is we discussed it is in gram per meter cube now when you multiply it with 10 to the power minus 8 will become kg per meter cube ok. So, kg per meter cube and meter cube meter cube will cross it down kg per day will become will be there in the numerator side and the denominator side divided by the volume of your aeration tank or volume of your tank say that is 1 meter cube. So, kg of BOD per day per meter cube it is the volumetric loading rate you understand this is called volumetric loading what is the volume of like you know like organic matter that is coming into the picture coming into your treatment unit. Next there comes the organic loading rate or food to microorganism ratio what is that organic loading rate it means the amount of BOD or amount of organic matter is applied per day per unit mass of organism present in the in your reactor say like aeration tank in general ok. How we can quantify it is very easy just remember you have a say one small tank aeration tank we call it in say we are when we are aerating when we are aerating that means, we are trying to grow aerobic bacteria it is a type of secondary treatment unit ok.

So, in the F by M ratio it is a food is what it is called organic loading rate or food by a microorganisms food what is the food here for this microorganisms what is the food here those organic matter which is coming from the influent and what is the influent flow rate it is Q and what is the major food here for them is the BOD. The organic matter which can be represented by BOD that means, food is the BOD we know the BOD of the influent waste water we know the influent flow rate. So, if you multiply flow rate with the BOD you will get the total kg of an organic matter kg of BOD per day that means, that much of food is coming to your treatment unit I mean like in your tank you can easily identify it is not it divided by the microorganisms what is the amount of microorganism present in your system for which this food is available this food which is coming. How we can quantify this microorganisms number of microorganisms present in your systems there is a way we there is a system ah like there is a ah passive way of doing it we remember we discussed about the VSS remember in solid analysis MLVSS or the simple VSS volatile suspended solid. If you know the volatile suspended solid in sometimes in aeration tank if you are keep on mixing it and if suppose the waste water is actually after the secondary sedimentation tank some of the sludge is recycled back to the aeration tank we will discuss about it why we do that.

So, in that case we call it MLVSS mixed liquor volatile suspended solid mixed liquor volatile suspended solid MLVSS. So, this MLVSS is a representative of the biomass organic biomass you understand. So, if you know the VSS that means, you know kind of

a that what is the amount of organisms present there in your system ok. That because that biomass represents the amount of organism microorganism ok. So, once you know the amount of microorganisms in milligram per liter if you multiplied with the the volume of that reactor you can easily get the total ah total volume of total ah weight of your microorganisms or total amount of your microorganisms present in the system the unit mass of your microorganisms which is in kg understand.

Because MLVSS all this units are also again milligram per liter or gram per meter cube if you have gram per meter cube multiplied by meter cube it will become gram you can easily find out the V into x this x is nothing, but the MLVSS in the aeration tank which I mean V into x t becomes gram on the top on the numerator part you have a q into BOD same you remember we discussed the BOD milligram per liter multiplied by 10 to the power minus 3 if you want do not want to do that in kg it q into BOD how it can convert q is in meter cube per day BOD is in meter per ah gram per meter cube or milligram per liter or gram per meter cube meter cube meter cube will cancel it will become gram per day and in the bottom also you have a gram. So, it will become now you can multiplied by 10 to the power 3 in the ah ah ah ah into a minus 3 in the both numerator and denominator it will become kg per ah day divided by kg. So, what will be the final unit is a kg of BOD applied per day per kg of biomass present in your reactor you understand this is called food to microorganism ratio. When the food is higher when the F by M ratio is higher that means, the amount of food is much higher than the microorganism that is a very good condition that means, your microorganisms are happy they have enough amount of food they will also try to proliferate more they will also do the reproduce and there will be more amount of ah microorganisms present. Sometimes if the F by M ratio is less that means, the food which is available for microorganisms present in aeration is less that means, your microorganisms are in starving condition ok.

So, F by M ratio is very important which in other words we called organic loading rate please try to understand it this F by M ratio will be very useful in our design in the later stage. We do some solid balance also it is normally determined by identifying the quantities of solid entering and leaving each of the unit operations ah this solid balance we we know that how we do that we know that total ah suspended solid also we can do that total solid also we can do that sometimes we do it with the total ah with the volatile suspended solid the VSS also ok. VSS is actually very important here because VSS gives us an idea about ah the amount of biomass actually which is leaving the system or not and all this things ok this x t is very important this VSS sometime. So, ah this is how it happens so, other than that we have a hydraulic profile which is also important. What is hydraulic profile? You can easily understand from the name itself it is used to identify the elevation of free surface of wastewater as it flows through the various treatment units.

Suppose this particular one is a design given for ah like you know influent pumping on the primary treatment ok. What is happening here? If you see in the left side there is a inlet influent line, influent line this elevation is 584.7 say like ah meter or say like in a sorry in say a centimeter from say like mean sea level ok. So, from mean sea level say 584.7 is the ah the say it can be centimeter it can be inch it can be other unit as millimeter other unit as well ok.

Suppose centimeter just to make it you know ah like to make it easier for us. So, say this is the centimeter. So, this much centimeter from the mean sea level is the elevation. This is the influent line from influent you have in the bottom you see this round thing it is the pump. So, it pump it to almost 619.

1 this is the elevation at which this is the discharge channel. From this discharge channel the water is coming to first aerated grid basin. Before coming into aerated grid basin suppose sometimes we may add some screen also. So, from that screen what will happen the screen the water will leave it will go to the aerated grid basin. If you see the water level in case of aerated grid basin the water level is almost 617.

9 in the in the very beginning at the end it will become 614.8. Then it comes to the say flocculation basin. In the flocculation basin the water level is 614.2 when at the effluent it will be after the baffles are added it is 612.5. Then in the wire crust it is 612 and from the primary basin when it go to the primary effluent minute monitoring metering and flow control structure it goes to goes to as low as 611.

So, 619 to 611. So, there is this gap there is this difference. So, this difference is created I mean like this difference is needed. So, that water will flow because of the gravity. So, to ensure the gravity flow of the reactor to each other. So, that will not have to use additional power because of implementing a additional pump it is very important that you design everything in such a way that the very beginning you put the water in a very high altitude and then because of the because of it is because of the gravity only it will go from one reactor to another and it will reduce the economic involvement like anything. The same can be seen for you know the trickling filter plant also in a trickling filter plant we will be discussing how trickling filter works in a in a maybe next to next module sometime somewhere also where we will be discussing about the in detail designing of what is trickling filter, but before going into the details do not have to worry about it forget about the name just realize that there is a certain elevation difference in the treatment the free surface of the water that we need to maintain.

You can see in the in the beginning is 611 at the end it goes down to 591.8. So, this is

the drop in the elevation free surface elevation on the on the free water surface elevation. So, that it will go the water will go through gravity from one chamber to another reactor to another. This is the plant layout this is almost the final layout is like you know we have to have a special arrangement that is in in plan and of the physical facilities of the treatment plant identified in the flow sheet and while making this special arrangement we have to take care of the accommodation of future augmentation of the treatment plant and some additional retrofitting also if possible. Obviously adding all the valves of the return sludge or the unit where the return sludge or return wastewater system has to be installed you know all these things has to be added.

This is the final plant layout how it will look like. Some key elements in the plant analysis and design first water first things first thing is we need to understand the raw water analysis it is the very first thing that we need to do to access the quality of the incoming water. Second is the treatment processes where to select the appropriate treatment module or the methods coagulation, sedimentation, filtration, disinfection all these things based on the identified contaminant in the beginning. Then the hydraulic design the determine the flow rate and the hydraulic characteristics of the pipe, tank and other component. Then the chemical dosing if it is needed for you know pH adjustment, disinfection etcetera too and at the end we have to make sure that when we will design this plant our wastewater has to be treated in a sustainable way so that that can be utilized for nutrient clear energy, clean energy as well as the clean water and the valuable byproduct for various other uses ok. Instrumentation and control is very important we need to understand the control and the sensors that will be using to monitor and the regular the treatment processes.

Safety measure is very important to prevent the you know accidents to handle the chemicals properly and to ensure the plant personnel safety. Residential management plan for the proper disposal and the use of treatment byproducts and the residuals. And the infrastructure design we have to have a proper design of physical layout of the plant including the building, operational building, the offices, the equipment placement, road access to the to the each and every infrastructure. The environmental considerations addressing the environmental impact assessment ensuring the compliance with the regulations we have to make sure that it goes ahead with the operation and maintenance plans like proper protocol of routine operations, maintenance and troubleshooting of equipment. Cost estimation is very important to estimate the capital and the operation cost involved with this plant design and constructions.

Military compliance very important that it is it should be adhering to the local state or the federal regulations governing the water treatment and also the future expansion. You have to have a scalability or the retrofitting capacity of your treatment plant. So, that in

future you can add some one or more unit or you can change the unit design and structure in some cases in case of retrofitting is needed. In conclusion we have discussed about the different treatment methods water treatment methods in the classification comparing the effluent characteristics and the effluent discharge. We discussed about the treatment methods in categorized in the physical unit operations, chemical unit process and biological unit process.

And we discussed about the plants different wastewater treatment plants into the primary secondary tertiary treatment and what are their basic goals and that plant analysis and the designing of elements what are the important nomenclature also we discussed. It is very important lecture you guys have to be very you know attentive in this and you have to really go through it once more. So, that you understand the basic nomenclature and the idea that I have just shared with you because it will be needed in the coming lecture module in a very regular basis ok. So, I hope you understand a very like this very basic and very important lecture module lecture of module 3 and this will make the foundation of our discussion in the coming weeks ok. So, thank you so much before going to I would like to request you to refer to this materials in case if you need it and we will meet you in the next lecture. Thank you so much.