

Water Quality Management Practices
Dr. Gourav Dhar Bhowmick
Agricultural and Food Engineering Department
Indian Institute of Technology Kharagpur
Week – 05
Lecture – 25

Hello everyone, welcome to this NPTEL online certification course on Water Quality Management Practices. My name is Gourav, Professor Gourav Dhar Bhowmick. I am from the Department of Agricultural and Food Engineering of India. So, in this particular module this is the last lecture of module 5, where we will be discussing about the rest of the section of the rest of the part of the flocculation and also we will discuss about the pre aeration systems. And also we will discuss overall what we have learned in about different primary treatment units in general. So, before starting the secondary treatment units, second discussion on the secondary treatment units will be having a glimpse of the primary treatment units and what are the basic primary treatment units that we normally have to install or incorporate in our treatment units, whether it be industry, whether it be municipality.

So, these are the different concepts that I will be covering the high rate flocculations, the pre aeration and the design configuration of different primary treatment units. Start with the high rate flocculations in general the aim of this high rate flocculation is to enhance the rate at which the flocs are formed subsequently reducing the detention time and increasing the loading rate. So, normally what we do we with the advancement in this technology we normally it comprises of by reducing the detention time significantly without compromising the effluent quality. So, this reduction in this detention time and increase in the loading rate it goes along with each other and which decreases the decrease in the former causes to later to increase.

And this kind of high rate flocculations can be of different types major the most famous ones are the ballistic, ballasted flocculations and the dense solid flocculation systems. So, in this kind of ballasted flocculation or dense solid flocculation that we will be discussing in coming slides. So, majorly they are combined with high rate settlers. Settlers means a certain structure where will be having couple of you know different type of plate like this one after another in a certain inclined position. So, that it will increase it will like kind of a enhance the settling rate enhance the settling rate or the clarification rate of clarification of solid from the system.

So, in general what we do we go for this ballasted flocculation as I was discussing it is a one type of high rate flocculation systems. For ballasted flocculation this ballasting agent in the form of silica micro sand we normally use in the range of 0.1 to 0.3

millimeter is we add it along with the metallic salt. So, please remember that we normally use this ballasting agent which is nothing, but the silica micro sand and in the range of 0.

1 to 0.3 millimeter with metallic salt. This ballastic flocculation can be readily employed to reduce the to produce high quality effluent treated water achieving 90 to 99 percent of turbidity removal and removal of suspended and colloidal particles obviously, I mean like which comes along with the turbidity obviously, this suspended particles anyway. So, this critical parameters which affect the efficiency of this ballasted flocculations are majorly the selection of coagulant, the type of polymer that you are providing that you are using, the concentration of the ballasting agent, the mixing intensity and the hydraulic loading rate. Typical liquid retention time in ballasted flocculation range from 10 to 15 minutes at max ok, which drastically reduces the minimize the footprint or the overall design footprint of the flocculation chamber.

So, the ballasted flocculation process is further divided into 3 major steps. First is the rapid mixing stage where the coagulant is added, second one is the maturation stage where micro sand as I was mentioning this is silica micro sand is fed into the system and the third one where the lamina settler is normally employed which we call the kind of a acting as a sedimentation unit my like you know a pre sedimentation unit kind of. In this kind of pre sedimentation unit what they do as I was mentioning it has a certain different layer of plate one after another it is placed. So, what is happening with the inclined manner the water will settle and it will slow because of the slope it will call it will be collected at a certain certain hooper I would say on the bottom in the hooper like structure. So, this 3 stage maturation this rapid mixing and maturation it of it looks like some something like this.

We normally first the influent is you know introduced in the coagulation chamber when the coagulant is added certain mixing is given mixing is provided with the mechanical mixer then that coagulant rich my like coagulant mixed water the waste water will come to the maturation on the flocculation chamber where the micro sand is introduced and the different kind of mining polymers are introduced. So, what is happening in the maturation flocculation chamber it is actually increasing the chances of floc formations drastically then it goes to the sedimentation process or the clarification process or the plate settler or the lamellar clarifier this kind of systems. This kind of systems when it is introduced in this kind of systems it can be those you know the solid particles will start settling on the bottom this you use sometimes the recirculation pump this solid particles only we somehow use the hydrocyclones and will take the complete the solid out and some amount of this micro sands particle again introduced to the system again in the maturation tank again. So, will reduce the overall like you know the doses of the micro sand doses of the polymer that that it requires by using this recirculation systems time to

time. So, this is the schematic diagram overall schematic diagram of the ballasted flocculation systems or flocculation process.

So, I hope you understand that the first is the coagulant dosing then the micro sand dosing and polymer dosing and the third one is the settling property settling phenomena. Settling phenomena is done by using different kind of plate settler or say like the lamellar settlers and from there the the sedimented sludge will be again put back to the hydrocyclones and from there we recycle some of the this micro sands. Next one is the high density sludge process high density sludge or HDS systems nowadays it becoming so popular it employs the recycling of chemically conditioned sludge to accelerate the rate of flocculation. So, it is more like you know we try to get rid of the flog in the form of sludge, but whereas in this kind of systems we introduce that sludge in a certain control manner because in order to enhance the rate of flocculation rather by because of its chemical properties. In general the HDS like the high density sludge we it begins with the feeding the waste water to a rapid mixture tank where the if you can see in the second one where the influent is mixed with the mixture of sludge and lime for about 5 minute to neutralize the acidic if influent if it is there.

Then the sludge lime mixture is introduced in in lime sludge mix tank and with the addition of the lime which is act as acting as a neutralizing agent and the coagulant. So, after then some portion of this sludge is again pumped back to the system the you know our to the unit again. So, that you know it will be a kind of a acting as a nourishing agent. So, majorly the aim of this neutralizing agent is to bring the pH of influent to a point at which the metal of concern become insoluble. So, this typically detention typical detention time which we normally provide in this kind of lime reactor is about 30 minutes to ensure the complete precipitation and the waste water is then mixed with the flocculant like polymers in a flocculators which promotes the bonding of chemically conditioned solid and suspended particles present in the waste water.

A part of the settled sludge we recycle back as I was mentioning and the rest is dispersed off from the clarifier. The sludge lime mixing prior to the neutralization is a vital component in this HDS process. So, the precipitation on the surface of the floc presents in the sludge normally increases the size and the density accelerating the overall coagulation in the flocculation process. So, this is how the high density sludge process we normally use this is also one type of flocculation it is a very advanced stage of advanced level of flocculation systems that we just discussed. So, in general if you talk about flocculation we talk about the general flocculation units and all, but now a days things have advanced in a different up to like really in a different level and that is the main motto of this subject like this particular course that we will discuss about the advancement in the different treatment unit.

And I will not go into the more in detail I will be discussing about the over only the brief because if you want to design in detail all all these things it will take good amount of time which is not not possible because of the time limitation of this course. But anyway you will get to know if I mean like in general my in my lecture in IIT Kharagpur here normally I give this designs in details. So, and also I have made this notes. So, those notes are also available. So, that can be that you can refer.

Another primary treatment system is what we call pre aeration in the wastewater treatment normally it involves the introduction of air into the raw primary wastewater before it undergoes the further treatment processes. Why we introduce the air into this raw wastewater we somehow aerate it even before the primary treatment primary treatment or the second treatment or the tertiary treatment. So, this pre aeration before the secondary treatment unit where normally we if there is a aerobic treatment unit we introduce the aeration for aerobic biological respiration process to undergone. So, before that also sometimes we aerate the system. So, why we do why we normally aerate the systems? There is a reason behind it that the reasons are first of all the order control to reduces the unpleasant orders by promoting the aerobic conditions.

We oxidize the I mean like enhances the oxidation of chemicals and aids in aerobic microorganisms to start breaking down the organic matter even if before it reaches the secondary treatment areas which sometimes it is not necessary as well, but in case to case basis where you have a footprint limitations and all you can actually start doing the pre aeration system. So, that aerobic bacteria can start you know settling down start acting on the organic substances and reduces the organic load. Hydrogen sulphide reduction that helps in reducing the hydrogen sulphide level addressing the order and the corrosion issues. Improve the settling properties the normally it aids in breaking of the solid facilitating the better settling during the sedimentation and also the pH adjustment. Obviously that influences the pH because contributing to a contributing to a more neutral and the slightly alkaline environment when we introduce the oxygen in general.

Because we know that the when normally the presence of carbon dioxide is more it makes the system acidic in acidic the environment acidic little bit acidic. So, if we really want to get rid of the carbon dioxide it will definitely make the system more neutral or even slightly alkaline in nature. So, we normally introduce this pre aeration to enhance the biodegradation in the follow up units by fostering the favorable environment for the aerobic bacteria to grow which reduces the biochemical oxygen demand. So, this is the pre aeration systems that the one of the last unit that I wanted to discuss with you about the primary treatment different type of primary treatment units that I have already discussed. So, here now for the next 5 to 10 minutes I will be giving you a overall pictures queue of what we have understood what we have learned in the last two lecture module what with the different type of primary treatment units.

The first one if you remember we started with the screening it uses the bar screen or the mesh screen to remove the large objects such as sticks, leaves, plastics and other debris from the waste water. The influent waste water passes through the screening mechanism while larger solids are physically blocked or removed. We also design different type of bar screen and we I think I am very much hopeful that you are very well like you know you can well understood the concept of bar screen and you can design it by yourself. The next one is the grid chamber grid chambers are designed to remove the heavy to heavy inorganic particles like sand gravel or grid from the waste water. The waste water enters the grid chamber and due to the reduced velocity the heavy particles settle on the bottom of the bottom of the grid chamber for removal.

So, what type of particles we normally get rid of it inorganic suspended solids isn't it you remember the sand gravels and grids. What happened to the organic suspended solids? If you remember for organic suspended solids we have primary sedimentation tank. So, because of that because of its organic in nature it requires a little bit of extra time ok. And so, this this clarifier or the primary clarifier sometimes we call it primary sedimentation tank. So, this allows a settling on the suspended organic solid under the influence of gravity.

So, normally waste water enters a huge tank where the velocity is reduced allowing the particles to settle and the settle solids which we call the primary sludge is then collected for further treatment aerobic or anaerobically. Normally we prefer the anaerobic treatment this primary sludge we will discuss about it. Next is the chemical coagulation and the flocculation we just discussed in last two two or three lecture series lecture lectures that the chemicals like alum or the ferric chloride we normally add to the waste water to create flocs which are larger and aggregated particles and that is easier to settle on the bottom. Now this process can be integrated into the primary sedimentation tank or occur in a separate unit separate flocculation or the coagulation unit. Then this primary treatment with anaerobic digestion as you know whatever the primary sludge that we find out that we normally get that primary sludge is nothing, but the organic high amount of organic fraction is is there.

So, that organic fraction needs to be treated. So, this organic fraction can be easily treated using anaerobic digester. So, this small anaerobic digester you can install to treat the the the the sludge primary sludge that is coming out of the primary clarifiers and once you treat that sludge in a anaerobically in anaerobic digester it will not only reduces the sludge load, but also it will it will give you a very important by product which we call the biogas. This biogas can be further used for any other purposes like normally we use it in the I mean like in a in a rural villages and all nowadays it is becoming quite popular. Forget about rural area even for the urban decentralized urban wastewater treatment systems also started utilizing these fundamentals and this biogas are I mean supplied for cooking purposes and all nowadays.

This is the the more smarter the city is come the design is coming the more start smarter we become and we started utilizing this kind of concepts in a very regular manner. So, what we do we normally use this anaerobic digestion to break down this organic matter or the primary sludge and produce the biogas and this primary sludge is normally direct direct you this producing to not only produce the biogas, but you know the definitely one of the major ingredients of biogas is the methane. So, sometimes we use the combined primary and the secondary treatments there is a combined combination of two two or three treatment we normally do to to make it more efficient and to make the design more I would say robust and modular in structure with a less like you know aerial footprint. The activator sludge systems like for examples can combine the primary sedimentation as well as the biological treatment in a single tank. However, normally in standard practice we use this ASPs or activator sludge processes as a secondary treatment unit.

So, I mean like this is this is possible to have combination of both primary and the secondary treatments in a same unit and one of the last system that I want to discuss about is the rotating biological contactor or RBC in short. This RBCs are the disk you can see this disk in the in the figure. So, there are like multiple different multiple disks disk are present in a one after another in a stacking stack together and they are mounted on a single shaft that shaft is keep on rotating slowly and what is happening on the top of this on the on the surface of this disk it has a lot of protrusions. In those protrusions are just favorable just perfectly designed to promote the growth of different type of microorganisms. So, what they are doing once they are in the water.

So, there they are there the waste water is there and once in there in air they are getting enough amount of oxygen enough amount of oxygen is a diffusion is happening from the air to the water surfaces whatever is present there in the bound water or the free water. So, this exchange of air actually increases the chances of the anaerobic aerobic microorganisms to flourish and the because of this aerobic microorganisms which are flourishing on the system which can reduces the presence of the organic matter and by this way it can actually reduces the overall biochemical oxygen demand or total like you know chemical oxygen demand of the system. In general this RBCs can be used as a part of the primary treatment processes specially in the smaller treatment units, but now it is even they are used in larger treatment units as well. This is very essential this RBCs can be actually you all of you can actually design by yourself and you can install it for treating your household waste water. It is in a very small scale you know school project or college project you can do and I mean you can simply install it right next to your I mean like right where the your waste water main waste water treatment system treatment line is sewer line is coming up.

So, in the sewer line you know like you know can have a small you can dug a small pond and they are like you know line it with the stainless steel mesh and then line it with the polyethylene foam and then polyethylene like poly liner and then you design a small

this kind of rotatory rotating biological contactor and somehow you are added with a small motor to make it slowly move and try to make as much protrusion as possible. So, to have maximum space for the microorganism to grow on the surface. So, that it will automatically started reducing the pollutant load in your system. So, perfect so, we discussed in this last two module we finished discussing different type of primary treatment units. We discussed about the different methods in this particular lecture we discussed about different flocculation methods like ballasted method ballasted flocculations high density sludge methods and all which improve the floc formation reduces the detention time and enhances the loading rate.

We discussed about the ballasted flocculation dense solid flocculations and HDS which contribute to the high rate flocculation ensuring the effective particle removal. We discussed about the pre aeration which can enhance the water waste water treatment efficiency by addressing the water the problem promoting oxidation reducing the hydrogen sulfide adding the settling properties adjusting the pH and also fostering the biodegradation by ensuring a greener and more effective process. More effective primary treatment units along with the chemical flocculation anaerobic digestion ensures the efficient debris removal while innovations like combined treatment and RBC or the rotating biological contactor technology can enhance the overall waste water treatment. So, this is where we are heading towards the future of treatment units different type of treatment designs and all. So, with this will this is the references that I would request you to go through and with this I will conclude the primary treatment unit designs and the discussion.

In the coming lecture in the sixth module will be discussed start discussing about the secondary treatment units and I hope you will be having a very fascinating journey towards like you know understanding the secondary treatment units because this is very interesting and you will it it involves different like you know science background together I mean like I would say like you need to understand the physics you need to understand the chemistry you need to understand the biology as well as it all combines together with the mathematics. So, then only you can understand the you know actual how you will end up designing water treatment units or the waste water treatment units in a more passionate way in a more better way ok. I hope you get to know something out of this module. So, see you in the next module. Thank you so much.