Wastewater Treatment and Recycling
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Lecture – 27
Wastewater Treatment Units : Primary Sedimentation (Contd.)

Hello friends. So, we are into the practically the last lecture of week 5. And, we will continue our discussion on Primary Sedimentation, as we were discussing in the earlier week. So, we did talk about the basic theory of sedimentation and what are the different zones of the settling tank.

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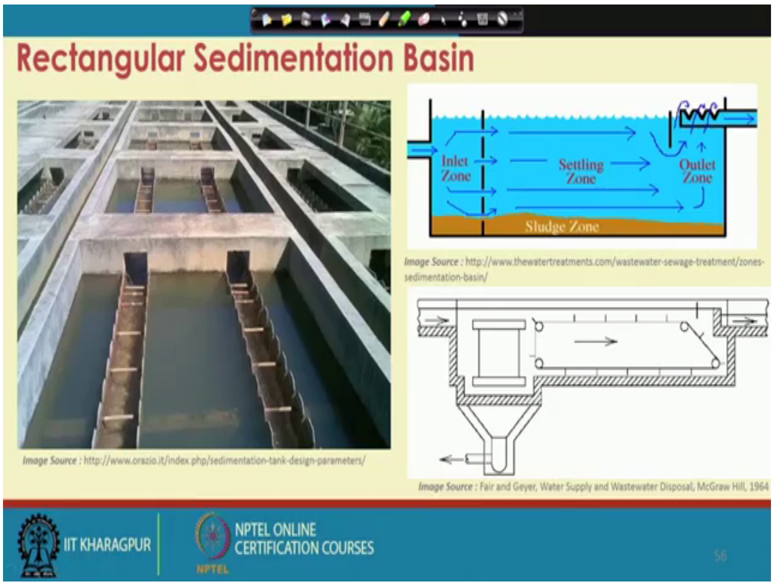

Now, we did discuss that there are couple of designs of sedimentation tanks; sedimentation tanks are primarily either rectangular type or circular type. Of course, there are others a few variant is a few other variants of this design is also available. So, like we can have a square sedimentation tank as well, but those are generally not preferred. So, the most common design of the sedimentation basins or settling basins are either rectangular sedimentation basin or circular sedimentation basin.

So, if you see a rectangular sedimentation basin, the inflow comes in here. And, then it first goes to a inlet zone as you can see from here and then it passes through settling zone eventually moves to the outflow zone and sludge is collected over here. So, these are the different zones the 4 zones that we discussed in the earlier lecture for a rectangular sedimentation basin.

We can have a sort of device like this plate like this, which can be used to rotate in order to push the particles which are being settled downward and eventually bring them down to the sludge zone. In practice in field typical rectangular sedimentation tank will look like this. So, this is your settling basin of course, here would be your then inlet arrangement, and then the water from here goes to this through these weirs goes to these launders and these connects eventually to the outflow zone.

So, that becomes your outlet arrangement and this is where this is basically the settling zone or settling basin. So, this is outlet zone settling zone of course, the other zones that we are not visible in this one, but that is how a typical rectangular sedimentation basin or settling tank looks like?

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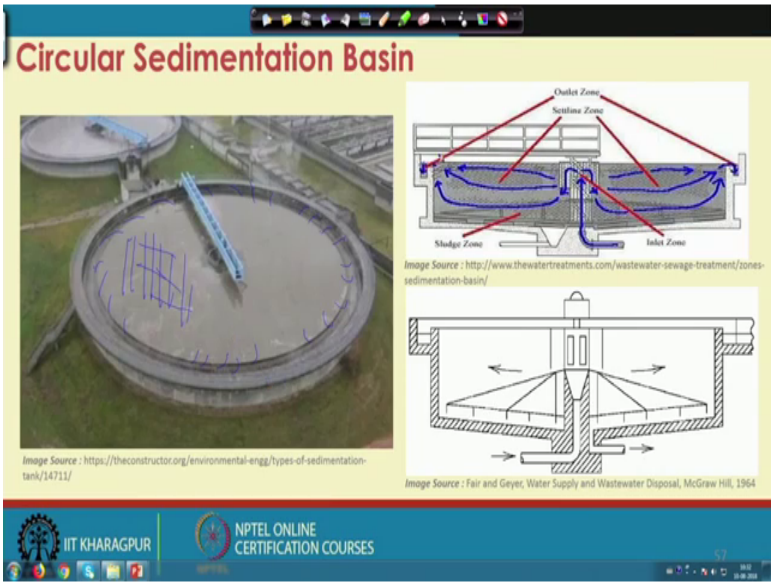

Now, if you see the circular sedimentation basin, it is actually in the circular shape as can be seen here. So, the flow typical flow arrangement in a circular sedimentation basin would be like this, you will have one will have inlet from bottom. So, circular sedimentation tanks are mostly a flow type. So, you will have inlet from here. And, then the water is pushed from this point forward it goes here.

So, this becomes your inlet zone. This is where the initial turbulence it is subsidized ok. And, then from here this arrangement the water comes and then water raises up through these it crosses these weirs to go to the outlet zone. So, outlet zone will be these weirs and it is across the periphery.

So, as you are seeing in this picture this whole thing is actually the like from this weir what whatever is the overflow generally overflow goes there. So, overflow from all this thing will be collected connected to this weir. And, that becomes the outlet zone. This is what you are seeing primarily is actually the settling zone and the water which is being pushed this point forward. So, here there is your inlet zone. And of course, in the bottom of this tank there would be sludge zone.

So, that way the overflow is pushed here settling process primarily takes place in the settling zone. So, this becomes your settling zone the large portion of the tank and the particle settle downs and then we have a mechanism to push those particles back here and then from here they can be collected. So, the bottom part; obviously, will become the sludge zone.

So, that is how it is the flow is in the upward direction. Typically the inlet is in the center outlet is across the periphery and the major other major part or central part of the tank this entire portion of the tank is actually your settling basin so, the main settling zone. So, that is how a typical circular sedimentation basin is conceptualized.

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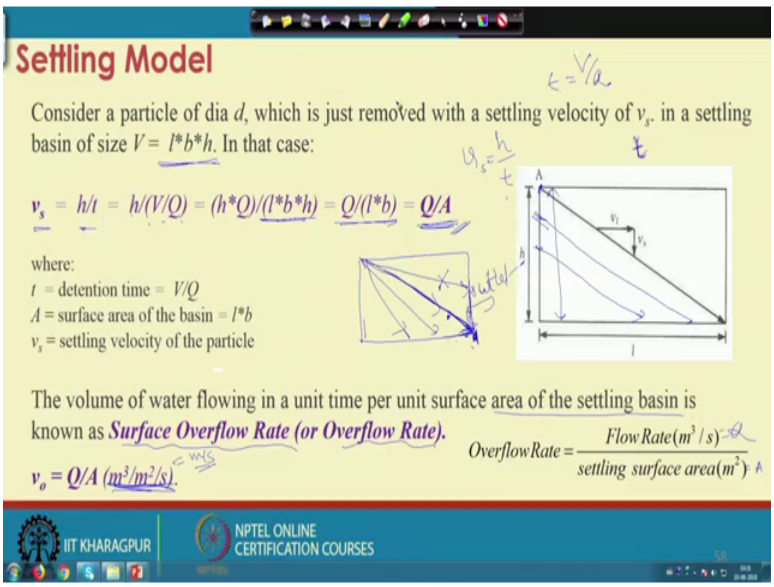

Now, if we see the theory of settling, or how particle settle the model of settling? So, let us say consider we have a particle of dia d, which is just removed with a settling velocity of v s. Just remove means that this particle as we discussed earlier that a particle in a settling basin a particle is considered to be removed when it hits the bottom part of the tank. When, it hits the anywhere in the sludge zone if it is hitting here if it is hitting here if it is hitting here we will consider that as a remove, but if it is les say it is here. So, we will not consider that as a remove will consider that particle as not removed.

So, that way we have if we consider a particle which is just removed; that means, we are talking about a particle which has just hit the core this corner and enter into the sludge zone. Because, any lower settling velocity will lead this particle to hit the outlet zone and then this particle will be washed out from the tank. So, this important to see at what velocity the particle is just removing because this provides us the critical velocity. So, any settling velocity settling velocity is higher than the velocity of this particle will get settle settling velocity, lower than this particle will not get settled as per the concept of ideal settling theory.

So, if a particle is just removed with the settling velocity v s, then the sort of if we see the settling basin which is of size l b into h. So, length of the basin is l height is h and of course, the third dimension width which is not visible will be b. So, in that case the settling velocity of the particle, what would be the settling velocity of the particle? So, if we see the downward velocity settling velocity through which it has settled. So, it has in t time if the particle has spent let us say t time in the reactor. So, in t time the particle which has entered here has travelled this much of vertical distance. So, this is the vertical distance it has traveled. So, the vertical velocity will be equal to the distance covered divided by the time taken in covering this distance.

Now, when we are considering a particle for a particle, which is just removed means if a particle entering here with the same settling velocity it, will; obviously, be easily removed, particle entering here will; obviously, be easily removed. So, just removal the critical case is the particle which is entering at the top and still getting removed. So, that is why we consider this case. So, h is let us say the height where the particle has entered. So, it has travelled h distance in t time. So, it is settling velocity is going to be h by t.

Now, we know that t is the detention time of the tank ok. And, the detention time will be equal to the volume over flow rate ok. Because, if the total volume of the basin is say 500 meter cube and your flow rate is 50 meter cube per hour or say per minute. So, if your flow rate is 50 meter cube per minute for our total volume of 500 meter cube so; that means, your 50 you can assimilate 10 times. So, 10 minute is going to be the detention time. So, V by Q is your detention time.

Now, if we replace this with the detention time. So, it becomes h by V by Q and V is your l b h Q goes up. So, that way we can solve this and we will get Q by l b or length into width is actually the plan area of the tank ok. So, this eventually becomes equal to the plan area of the tank. Now, if you recall Q by A. If from earlier lecture we discussed that the if we divide the flow with the plan area of the tank, what we get is the surface overflow rate or what we call as overflow rate also.

So, for a critical case the settling velocity of a particle is going to be equal to the overflow rate. Or in other way we can say a particle having settling velocity equal to overflow rate is likely to be removed and particles with lower settling velocity may not get removed completely or particles with higher settling velocity, because velocity is high. So, they will easily get removed that way.

So, the volume of water which flows in a unit time per unit surface area in the settling basin is typically known as surface overflow rate or overflow rate, which is equal to the flow rate or discharge Q divided by the plan surface area of the tank A. Now, the unit of discharge would typically be meter cube per second or meter cube per hour and unit of surface area is meter square.

So, that way this unit becomes equal to the velocity, but overflow rates are not presented in a unit of velocity ok. For the unit of velocity or unit of settling velocity or flow through velocity we typically represent as meter per second. The unit of overflow rate is also same, but it is not presented in a meter per second, but rather in meter cube per meter square per second.

So, that way it will eventually be equal to meter per second, but if you see the point of putting it as a meter cube per meter square per second because this gives you a better idea, that it is the flow rate which is in the meter cube per second divided by the surface area of the tank. So, that is how the overflow rate is conceptualized.

Now, other way also if you see that you are putting a flow through a tank and plan area of the tank is say a which is your l into b. So, plan area of the tank is l into b and you are putting the flow, flow is as we were seeing earlier just when we are looking at the rectangular or circular sedimentation basins. So, you see here that the it is actually the overflow from this area which is it is the overflow from this area which is eventually get collected in the outlet ok.

So, when we say the surface overflow rate it means from the entire surface, how much flow is actually going out per unit area. So, this is the total discharge; obviously, what is the inflow the same amount will be actually coming out in equilibrium the inflow is going to be equal to the outflow. So, the discharge of the outflow is going to be the same, but what amount is being spilled out per unit area of the tank is; what is your surface overflow rate?

So, that is why we call it is the overflow from a surface of area l into b ok. Or in this case in a circular case pi d square by 4, which is the area of the tank that way. So, this way we can have an estimation of the surface overflow rate which is going to be equal to settling velocity.

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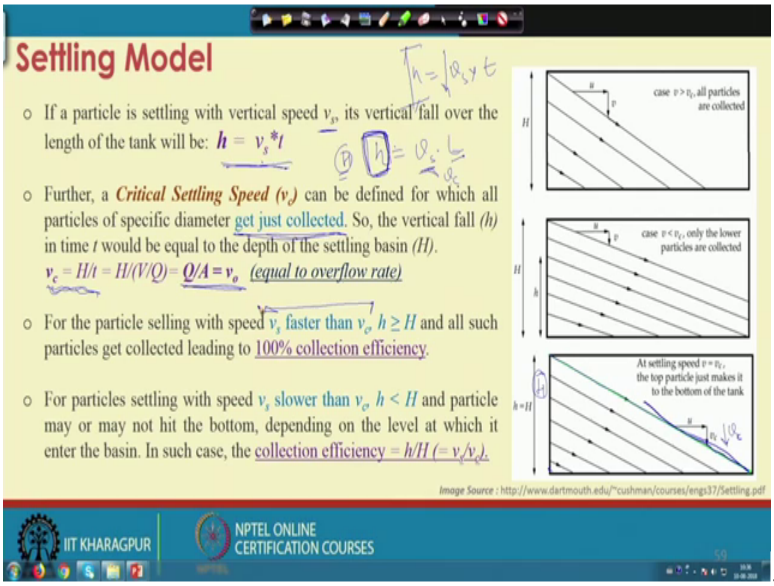

And, this is actually one of the critical information which is typically used while designing the tank.

Now, if a particle with settling speed or settling velocity v s, it is vertical fall how much it is going to fall will be equal to h by t, because as we defined earlier v s is equal to h by t. So, h the vertical fall a particle will take will be equal to it is settling speed into t. So, if a downward settling speed of the particle is let us say v s and it is spending t time in the tank. So, the total distance it is likely to cover h will be equal to q settling velocity times t. So, that is the total vertical fall a particle is expected to take ok.

Now, if you see as we are discussing, if you if we let us say define something which is called critical settling velocity or critical settling speed ok. Which is the velocity for which all particles of a specific diameter gets just collected. So, means they get just removed that is the critical settling velocity. So, if we have a tank of say if we have a tank of say height is equal to h, the total tank height is h. So, critical settling velocity means particle of dia any specific dia is just gets collected. So, as you are seeing earlier so; that means, this is going to be the trajectory of the particle in consideration. And, the settling velocity or vertical velocity of this particle v c, which is critical velocity is the one which will guide this ok. It is which is being indicated as it is getting just collected.

So, if it is just collected means anything lower than this will; obviously, be collected higher than this may not be collected and that is why we call it just collected. So, you are settling critical settling velocity in that case is going to be the depth of the tank, which is capital H divided by t or we can have in a same way which is equal to Q by A or v 0. So, this is equal to the overflow rate.

Now, for design purpose what typically we do we estimate the critical settling velocity or estimate the settling velocity of a particle, which we want to settle from a stokes law that some measures, and then equate that to the overflow rate and when we equate that to surface overflow rate. So, we know the Q value and we know the settling velocity of the particle critical settling velocity of the particle. So, that way we can determine the plan area of the tank.

So, if we try to see the efficiency of the particles which are settling. So, because vc is the critical velocity this v c is the critical velocity. So, any particle, which is having the velocity or settling velocity greater than this critical settling velocity so, if v s here is say greater than v c. So, then h here is going to be actually because h is equal to v s times t.

So, a particle the vertical fall a particle attains here actually is equal to it is settling velocity times t right and for a critical settling velocity the vertical fall that a particle attains is h. So, if your v s is equal to v c your h is equal to h in that case, but if your v c if your v s is larger than v c ok. If your particle is settling at a speed faster than v c if you are if say the selected particle or the desired particle is settling at a faster speed than v c in that case, you are the h that you are going to get which is equal to v s times t.

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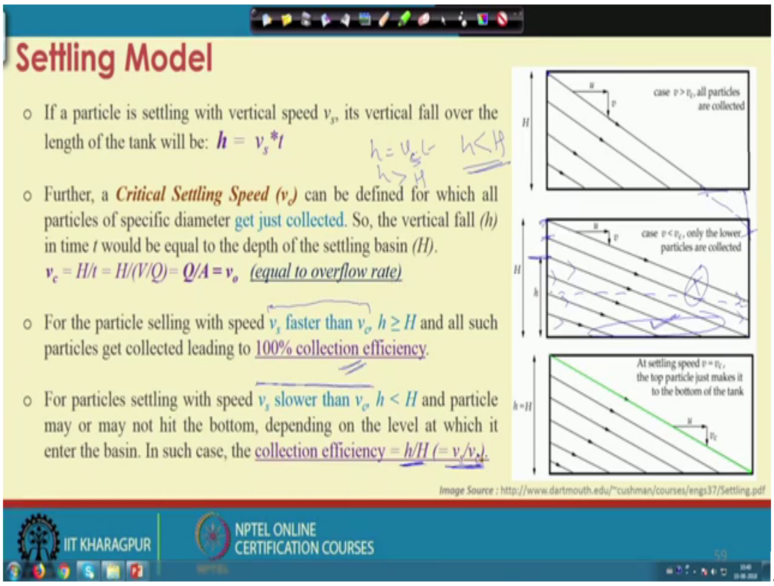

And, v s is being greater than v c. So, you are h eventually is going to be greater than h capital H.

So, the fall that particle will take or the distance that particle can travel in a given amount of time is actually going to be the greater than the depth of the tank. So, if let us say this is the case. So, particle starting from here, if it is velocity is higher. So, it will actually it can travel the typical h is this much, but in the same time it can travel actually a distance greater than h.

Of course, it need not to travel this distance because it will hit the bottom of the particle, but; that means, it is going to hit the bottom of particle much before the corner. So, all such particles with higher velocity will is bound to hit the bottom of the tank and will not go into the outlet zone. And, that way all such particles will get collected in the tank and will have a 100 percent collection efficiency for all such particle, which are having settling velocity greater than critical settling velocity.

So, as their the vertical distance they can travel is higher than the depth of the tank and that is why they can easily get collected. On the other hand the particles, which are having settling velocities slower than the critical settling velocity. So, in that case if your v s is smaller than v c. So, the h you are going to get is actually smaller than capital H.

Now, a particle may need to travel this capital H distance in order to get collected, if it is entering at this point. So, for such cases the particle which is entering here will be traveling a distance which is actually smaller than h. And, those particles which are entering here or entering here, may not get removed because they are not able to travel the entire depth, they are not able to cover this entire depth in the amount of time which they are spending within the time.

And, that leads that particle will hit the outlet zone and may get collected, the particles which are actually entering at a depth h because this is the depth that they can cover. So, the particles which are entering at a depth h or lower than h so, those particles only will be able to hit the bottom and get collected.

So, in that case your collection efficiency may not be hundred percent because these particles are not getting collected while these particles may get collected depending. So, collection efficiency will eventually depend, where the particle is entering in the tank or at which level the particle is entering into the basin.

So, in such cases your collection efficiency is definitely not going to be 100 percent, because some particles may hit the outlet zone and as a result you will see that collection efficiency is given by the ratio of h over H. Or because the time is same and h as we can write v s into t and capital H as v c into t. So, it is going to be the ratio of the settling velocity of the particle versus critical settling velocity ok.

And, that is how this will be the collection efficiency of the particle and that way we can estimate, how much particles are going to be collected in the system?.

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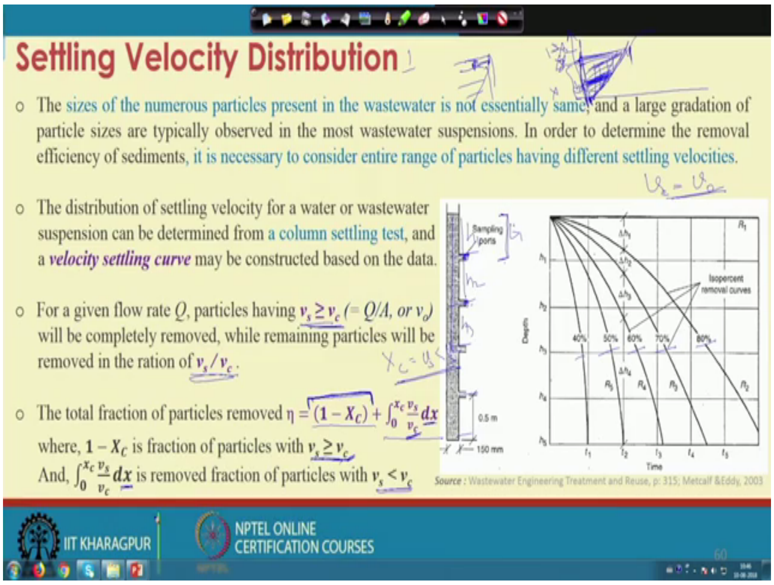

Now, what happens that the size of the numerous particle in the sewage in the waste water are not same. In ideal settling tank we are saying that the particle having a settling velocity, let us say which is greater than vc or lesser than vc, but what happens in an actual sample, since your particle size distribution varies over a range of dimensions.

So, there is a good gradation of the typical particle size which are present in the waste water or even in the waters. So, in that case the different size of particles will have different settling velocity. And, that way we like if we want to know the total removal efficiency of this tank, total removal efficiency of the particle.

So, we have to consider this entire range of particle having different settling velocities. So, how do we do that because theoretically it is not possible there are n different size ranges of the particle, and it is practically not possible for each and every individual diameter you determine the diameter of the pipe and how much of that particle is going to collected? What is going to be the efficient settling or collection efficiency for that particle which is going to vary based on the dia and dia.

So, typically for such purpose the column test is conducted, which is called column settling test and, based on that a velocity settling curve may be constructed depending on the data or based on the data that we have. So, typical column settling test is something like this we have a column, where we collect at different depths we collect samples at different depth. And, we determine how much samples have been collected and what is retained in the column?

So, this sampling is done at a different time and based on these different times. So, some particles which is let us say being collected here or some particle which is collected here in a time. So, the particles which is getting collected here has a settling velocity of because it has travelled this much distance in the given time. So, if say time t 1. So, in t 1 time this has covered say h 1 distance, while the particle which is being collected here has covered h 2 distance and particle which has been collected here has covered h 3 distance.

So, that way the different particles will have will have travel different distances in a any amount of time and we basically draw this. So, ISO percent removal curve we draw the 80 percent removal curve, 70 percent removal curve, 60 percent removal curve, 40 percent removal curve and based on that we can sort of analyze it.

So, if we want to know the total efficiency of the tanks for a given flow rate Q, the particles which are having settling velocity greater than equal to critical settling velocity will be completely removed. As we were just discussing, while the remaining particles which have settling velocity less than critical settling velocity will be removed in the ratio of v s versus v c.

So, the total fraction of the particle which is removed will be equal to 1 minus X C plus integration from 0 to x c and settling velocity versus critical settling velocity by d x into d x. So, what this eventually represent if you see, now if say the X is the fraction of particle which is having settling velocity lower than critical settling velocity.

Now, if X is such fraction of particle; that means, 1 minus X c is the fraction of particles which are having settling velocity greater than critical settling velocity and, as we know that all of this particle 100 percent of these particles are going to get removed. So, removal efficiency will straightaway have this component one minus X C.

Because, these are the particles with settling velocity greater than critical settling velocity and all of them are going to get removed, while for the smaller particle the X c fraction, it will depend on let us say because if we plot this data. So, we will get maybe a curve like this say. Now, this is the fraction removed say your x. So, what happens that up to this x or which is your 1 minus X c is completely removed and this is your zone of x where only particles which are, basically you need to determine the area under the curve. And, how we determine the area under the curve we have to integrate it right.

So, we integrate because v s by v c is the ratio of the particle which has removed. So, we integrate this v s by v c over a small slit d x and let us say this is my elementary thickness d x in this. So, I integrate this value from a point here to here or from a point here to here. And so, when I integrate from a point here to here the area of this curve, which I will get on this axis is going to be equal to the amount of particles or fraction of particles, which will be removed. So, this is the removed fraction of particles, which are having settling velocity lower than v c.

So, these are for a continuous curve we can discretize it also. So, for discretization we can sort of take the small values of d x and on this curve we can take the if let us say this is the velocity. So, we can take the average of this and multiply it with the d x. Of course, our v c or critical settling velocity is going to be constant because v c is equal to overflow rate, surface overflow rate.

So, for a given tank size our surface overflow rate or the critical settling velocity is constant. So, this we can take out and then eventually what we need to determine from this one is that c being a constant. So, this will be converted as integration, 0 to x c 1 my 1 upon v c or one upon v o whatever we the rho right and then v s into d x.

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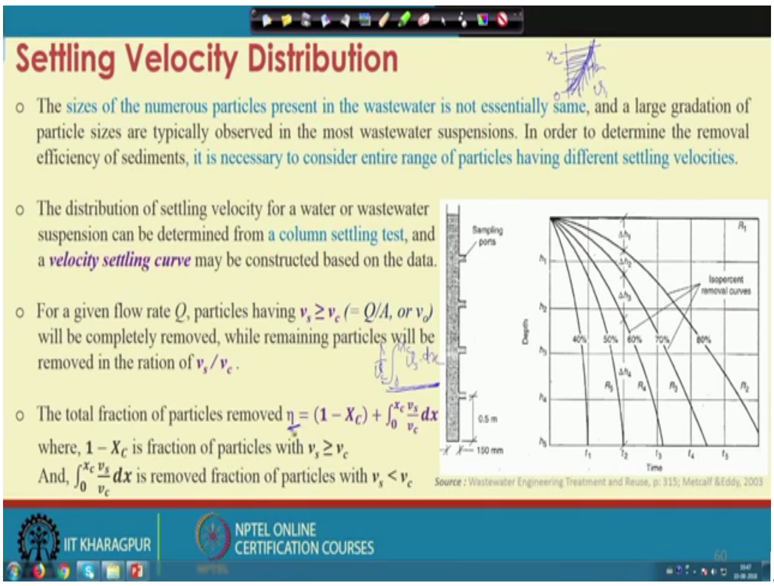

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So, it is basically this area that we need to determine and as we were suggesting that if you have a curve like this. So, if we integrate we take a small d x and integrate it from point 0 to say x c, this is my settling velocity v s curve. So, this curve settling velocity curves we will get area under this curve and for discretized manner we can take different values of x, and corresponding average value and multiply that in order to get the area. So, that is how we can actually determine the net removal for varying particle size.

Now, this concept is practically very useful in terms of wastewater because in the wastewater, it is not always discrete settling or ideal discrete settling.

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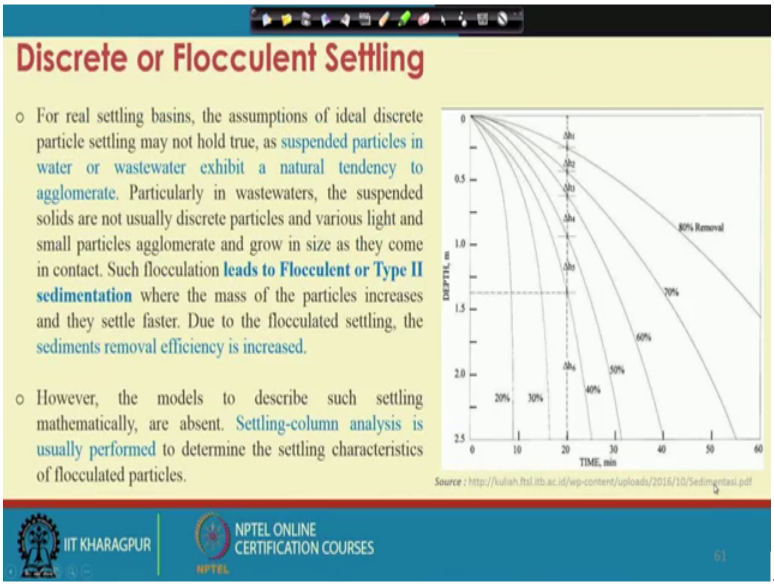

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So, for real settling basins there is assumptions of ideal discrete particle settling does not hold true often, that is because there is suspended particles in water and wastewater generally exhibits a natural tendency to agglomerate. Particularly in the wastewater if we see the suspended solids are not like truly discrete particle, there are various lightweight particle, there are various small particles and when they come into the contact they agglomerate from a larger type of this thing. And, as a result their flocculation occurs and this leads to the type 2 or flocculent type settling which we discussed in the earlier lecture.

So, settling essentially may not be the discrete type one or ideal settling which we are discussing. So, far it may be of a flocculent type settling, in a flocculent type settling is better because settling velocity increases and we can get the particle settle in a lesser amount of time. So, that is in fact, not a bad thing to have.

However, there is no as such model exists which can sort of describe the flocculent type settling of the various particles or various flocks formation mathematically. So, then settling column analysis is usually performed as we were discussing and same way we can determine the settling characteristic and removal characteristic of the particles ok. So, that is what is typically of very high application particularly when we design a settling basin for wastewater treatment ok.

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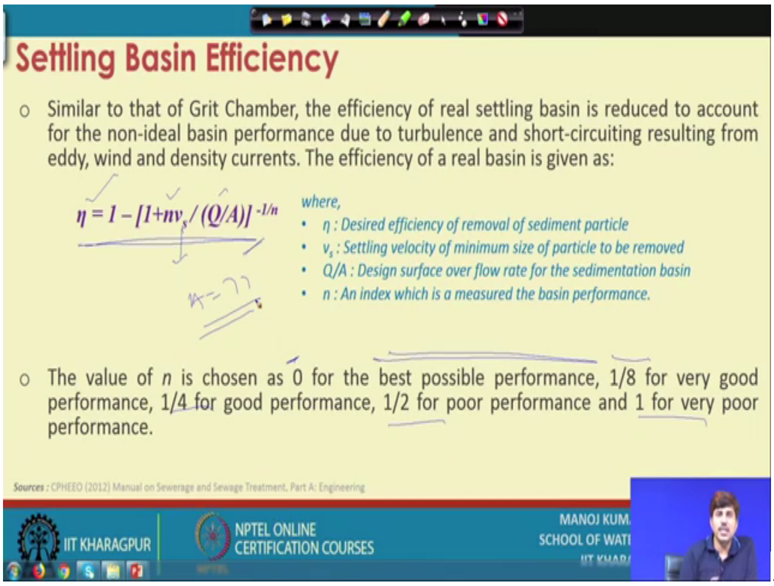

Now, the basin efficiency again is not always ideal as we consider for ideal settling basin and this non ideal performance similar to the grit chamber that we discussed would be because of the turbulence or short circuiting which results from eddy wind or density currents. So, the same kind of approach is adopted in order to estimate the efficiency. So, if this formula would be appearing you are familiar because we discussed this in a great removal sense also. So, it is the same thing and here the value of n is chosen 0 for the best possible performance ok.

So, if value of n becomes 0 your efficiency becomes equal to 1, it is considered 1 by 8 for very good 1 by 4 for good 1 by 2 for poor and 1 for very poor performance. So, based on this we can if we consider say desired removal efficiency, we know the value of n we know the settling velocity we know the discharge. So, we can determine the area from here for in real settling basin and not the ideal 1 ok.

So, that is how basically we can design or we can get than the sedimentation part.

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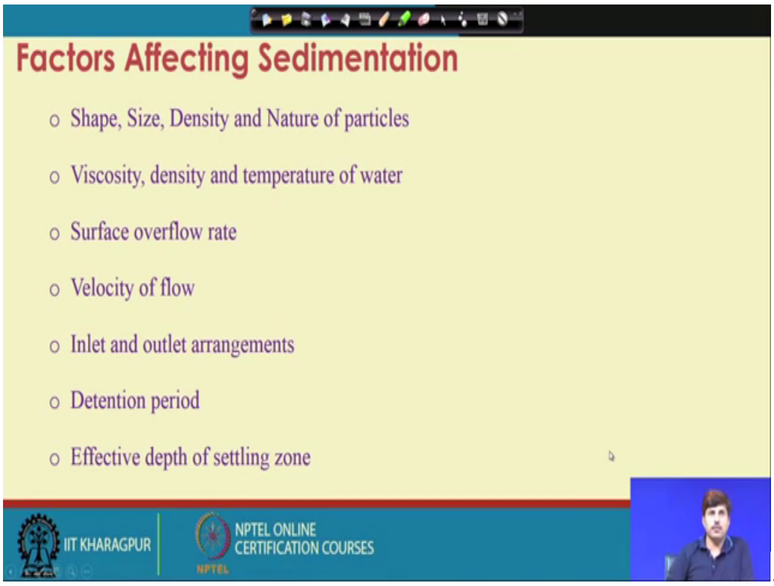

If, we see the various factors that affect sedimentation there is shape, size, density and nature of the particles, viscosity density and temperature of the water, then what is the surface overflow rate, velocity of flow inlet and outlet arrangements what kind of turbulence they are leading to what is the detention period, what is the effective zone of the effective depth of the settling zone?

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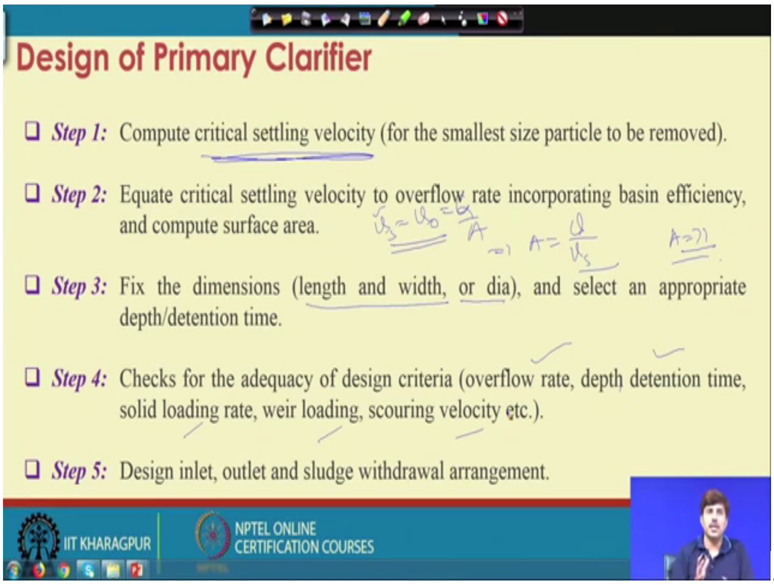

So, all these part things are the one which decides the efficiency or performance of a settling basin.

Now, for design purpose there are several things that needs to be done. So, their first step would be to compute the critical settling velocity for the smallest size of particle to be removed. So, if you want to let us say remove a 0.0 to mm size particle. So, use this dia put that in a Stokes law and determine the critical settling velocity.

Determine the Reynold number see if it is less than 1, fine if it is not less than 1 go to the turbulent equation, use that dia estimated, use that settling velocity estimated get the Reynold number get the drag coefficient. And through trial and error reach critical settling velocity for the particle of the small s dia. So, that becomes the very first step.

Now, this critical settling velocity is equated or is kept equal to the over flow rate incorporating basin efficiency and then we compute the surface area. So, as we are just seeing the equation for the basin efficiency. So, considering up of like performance of a efficiency or the value of 1 by n or and what we can do is we can reach we know the settling velocity, we can equate that to overflow rate for ideal settling basin we can just keep settling velocity equal to overflow rate, which is equal to Q by A. So, we know the settling velocity.

So, from here A becomes Q, by the settling velocity, but for real settling basins we will go to the we will use the formula, which we were just seeing and then from considering an efficiency of settling and n value and this thing we can compute A from that formula as well.

So, once we know the a we can fix the dimension either in terms of length or width or dia there are certain criteria's, which are adopted typically in fixing these dimensions. And, then we can select an appropriate depth and detention time, we need to check these designs for adequacy of various design criteria which would be in the terms of overflow rate depth detention time, solid loading rate, weir loading a scoring velocity etcetera.

So, all these things are checked and then we can put sludge inlet we can like sludge withdrawal mechanism and inlet and outlet arrangement we can design, the freeboard required freeboard we can provide. So, those are the other design aspects which needs to be followed.

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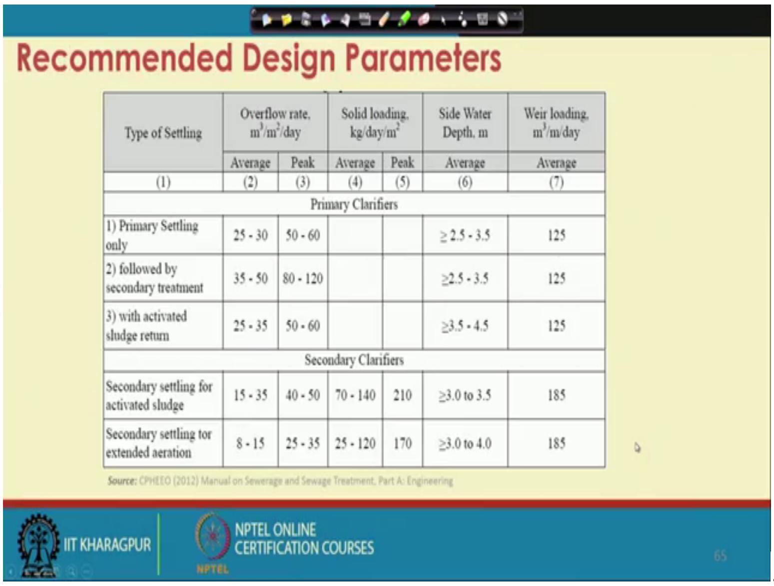

Type of Settling	Overflow rate, $m^3/m^2/day$		Solid loading, $kg/day/m^2$		Side Water Depth, m	Weir loading, $m^3/m/day$
	Average	Peak	Average	Peak	Average	Average
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Primary Clarifiers						
1) Primary Settling only	25 - 30	50 - 60			≥ 2.5 - 3.5	125
2) followed by secondary treatment	35 - 50	80 - 120			≥2.5 - 3.5	125
3) with activated sludge return	25 - 35	50 - 60			≥3.5 - 4.5	125
Secondary Clarifiers						
Secondary settling for activated sludge	15 - 35	40 - 50	70 - 140	210	≥3.0 to 3.5	185
Secondary settling tor extended aeration	8 - 15	25 - 35	25 - 120	170	≥3.0 to 4.0	185

If, we see the recommended design parameter for wastewater primary sedimentation treating wastewater, so, for primary settling only the overflow rate should be in the range of 25 to 30, while it could be P could be 50 to 60 ok. If it is if it has to be followed by the secondary treatment we can have a higher overflow rate, because some part can be get settled in there as well and for activated sludge return if it is there we can have this range. So, that way there are various criteria for weir loading rate and then side water depth, what should be the range of side water depth in such cases, because that is what eventually controls the depth in the tank.

So, that way we can use these design parameters for the design purpose and cross checking.

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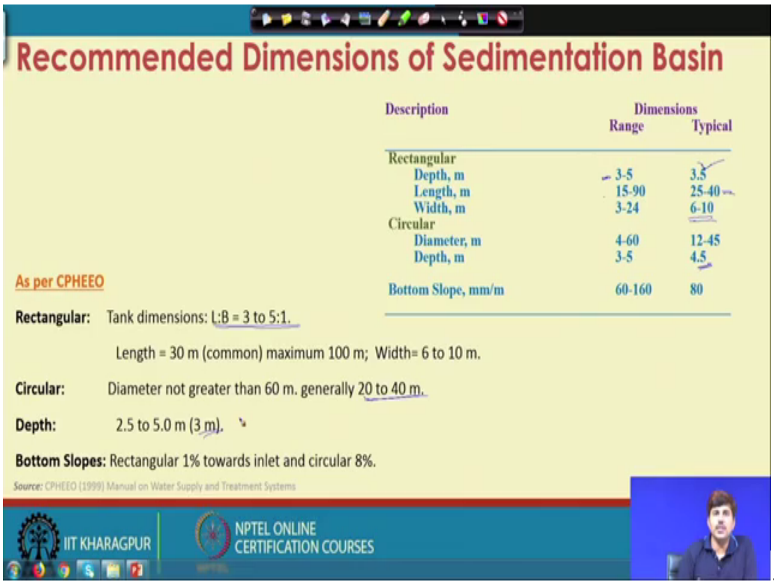

The dimension of the tank are also sort of guided that we can have a certain ranges for the dimension, for rectangular tanks the depth should be between 3 to 53.5 is the typical value used lengths would be 15 to as high as 90, but it is 25 to 40 meter which are typically used. And, similarly 6 to 10 is the typical range for the width. For circulars diameter can be as high as 60, but again it is 12 to 40, which are the typical values used and depth again could be 3.5, we can have higher depth in the circular settling tanks because of it is of flow nature.

So, that way we can go to a depth of around 4.5. The bottom slope is considered 60 to 160 is the range typically, and it is the typical value if we follow the manual. So, C P hoc is that length to width ratio should be 3 to 5 times 3 to 5 is to 1. So, either 3 is to 1 4 is to 1 5 is to 1 or 3.5 that way the length 30 meter is common maximum could go 200 meter width is 6 to 10 meters. For circular diameter should not be greater than 60 generally 20 to 40 is recommended as per the manual depth again a normal depth would be 3 percent and bottom slope for rectangular, it is one percent towards inlet while in circular it is 8 percent towards the center.

So, these are the typical design parameters which are used.

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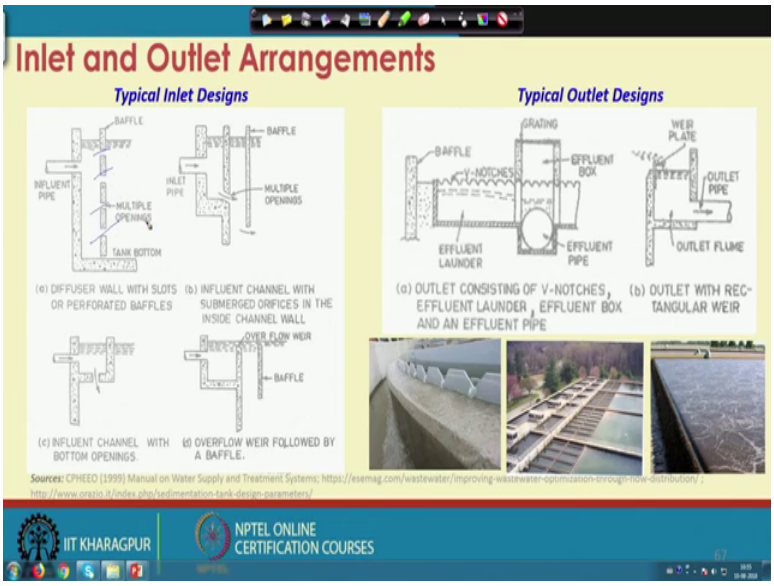

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So, that talks about the main part or main design of the settling zone. Of course, there has to be supplemented within various inlet and outlet arrangement. So, these typical inlet arrangements as we brief earlier also, we need to put as a baffle with multiple opening or this thing. So, which can evenly distribute the water in the basin, or we can have a system like this inlet pipe from where it skids through and then it through like multiple opening it goes into the main settling basin.

We can have a system like this where water is collected on the top and then from bottom it is it goes into the tank. So, the turbulence portion is subsidized here only same design is this one turbulence portion is subsidized here and the overflow from this goes to in this one and then there is another baffle which sort of smoothen the transaction into the settling zone.

So, these are some of the typical inlet arrangement. Similarly, we have various outlet arrangements, which could be in the form of V-notch effluent launders effluent box or effluent pipes. So, this is a kind of V-notch pipe that you can see here this is one of the most common and most effective way.

So, we can have those v notches ok. We can have outlet with rectangular we are in the form of we R plate. So, though we R plate this actually flows through flows through this and then come to the outlet launder, we can have launders over here again the like you are having this kind of channel. So, water which is overflowing from here, eventually going eventually goes collects in these drains and then from these drains it connects to the outlet chamber this example of how the overflow is collected?

So, this kind of inlet and outlet arrangements can be made, which can serve the purpose.

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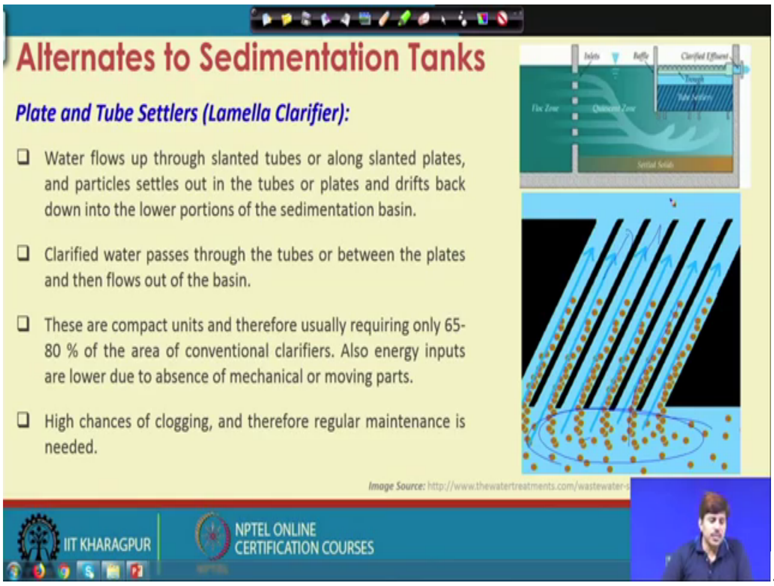

The last thing we did like to briefly discuss is that there are certain alternates also to the sedimentation tank. So, these days particularly for a smaller setups, because with the large setup it becomes difficult, but for smaller setups or industrial or even some cases water treatment systems not that in the wastewater, but more in through the water treatment, even some industrial effluent treatment systems also the it is actually plate or tube settlers are used which are often like considered as kind of lamella clarifier.

So, what happens? That water flows through these slanted tubes are slanted plates and particles. So, it is like this the water which is containing particle will move up on in these tubes or plates. And, then particle what happens it hits the surface and then drifts back down to the lower portion and then settles over here. So, the particles will remain accumulated will settle and will drift down here whereas, your water can easily flow up.

So, clarified water passes through the tubes or between the plates depending on whether it is tube settler or plate settler and then flows out of the basin. It has a certain distinct advantages the performance is very good first thing and then it is a compact unit. So, therefore, the total area require because you do not have as such off like those inlet arrangements outlet arrangements and so, many other things.

So, generally the area required is lesser than that of the conventional clarifiers, it can be as low as 65 to 8 percent of the conventional clarifier or alternatively if you have a size of clarifier, and you pack with the such systems you can deal with the larger flow rates ok. So, with the same area you can have you can achieve higher flow rates. Energy inputs are also lower because there is no mechanical or moving part as in case of like rectangular we saw that, there would be arrangements for moving the particle circular also you have a things rotating in order to push the sludge particles back.

So, generally these play taught you clarifiers lamella clarifiers are free of those kind of equipment's and that is why the energy input are also lower. However, it is not very applicable to the larger systems primarily because there are high chances of clogging particularly with the waste waters which may have lot of sediments a lot of such particles.

And therefore, it needs regular maintenance otherwise the otherwise what happens that the flow distribution does not remain even. Some may get choked some may get not choked so, then from other tubes because your discharge is constant. So, you may get higher velocity you may get those kind of issues coming in these type of system.

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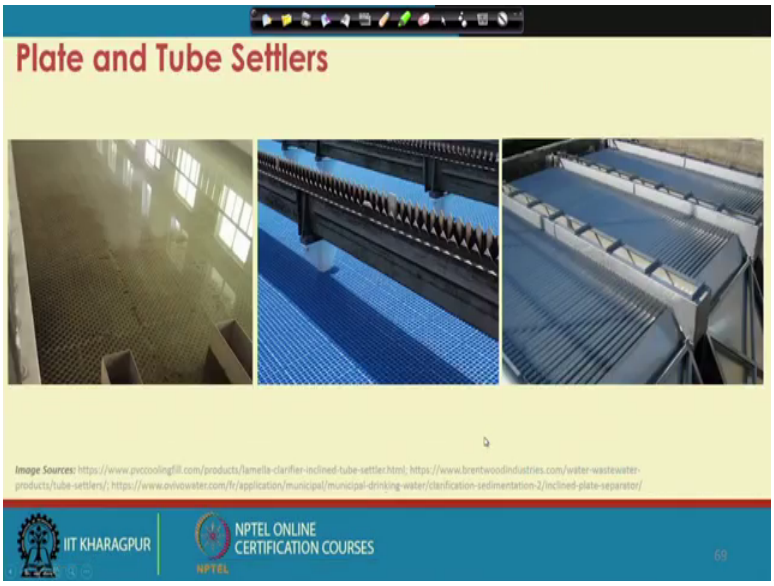

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So, that is why this restricts it is applicability little these are some of the such systems. So, you can have a plate clarifier like this where, you see that the flow from downward pushed through this and then the flow will be connected here. This is kind of tubes slanted tubes or this kind; so, this kind of structure and arrangements can be packed for the plate or tube settlers.

So, these are the typical design of plate and tube settlers. So, with this we conclude the discussions for this week we would be having some practical some practice problems, some numerical problems on the discussion that we had. So, that either we will do as a supplementary video or we will put through as a lecture material some solved tutorial problems and some maybe unsolved tutorial problems for practice purpose which will be uploaded.

So, thank you and see you all next week.