Water Supply Engineering
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Lecture-30
Coagulation and Flocculation Design Operation and Process Control

Welcome back friends this week we have been talking about conventional water systems and so far in last couple of lectures we discussed about the coagulation and flocculation process. So, we started with the basics of coagulation and flocculation and we did study about the basic process. Now let us see about the how it is implemented in the field so what kind of Units we provide in the field for coagulation and flocculation purpose. How do we design them of course will not be covering the entire design.

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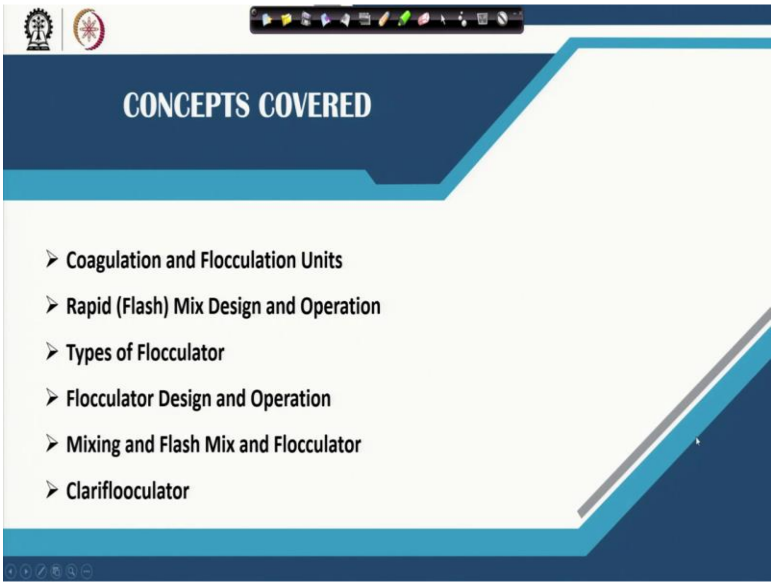

But we have like basic understanding of how these systems are designed and then how they operate in the field. So, the concepts that we are going to cover here is the basic coagulation flocculation units which are basically the rapid mix and flocculator. So, we will be talking about the flash mixture design and operation will be talking about what are the different type of flocculator which are used.

And then the flocculator design and operation for some of them of course we will touch upon this briefly. And then what is the importance of mixing in the flash mix and the flocculator that also we will be discussing. And we will be concluding with some brief notes on the clariflocculator.

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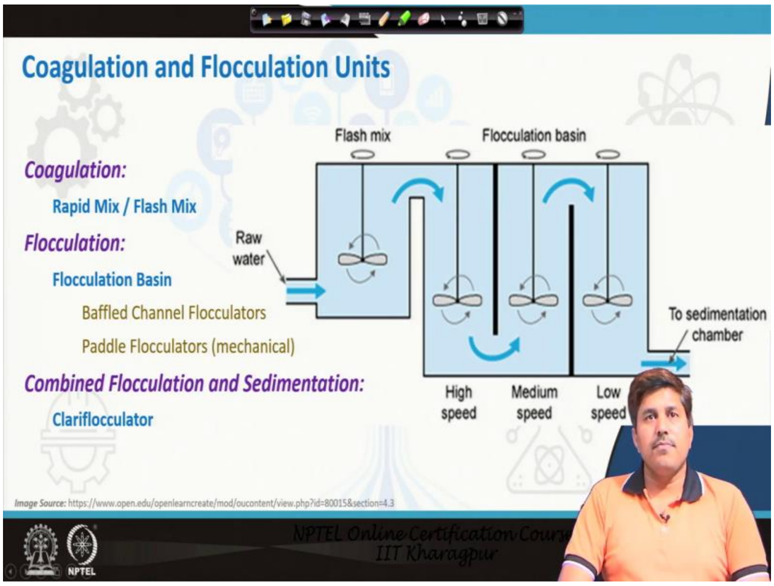

So, basically the coagulation and flocculation unit if you want to like deploy the coagulation and flocculation process in the field so what as we discussed earlier also that what we need to do is we need to select a coagulant and then we need to add that coagulant we need to kind of let the flocculation happen and then once the flocculation completes. We need to remove the floc's that are formed.

Now that removal process happens in the sedimentation which we had earlier discussed but the basic that the correlation process like when we add the coagulant, so first step or first unit that we typically need is rapid mix. So, it is practically the rapid mix or it is also known as the flash mixture that is where basically we rapidly mix the added chemical which is coagulant so that it gets homogeneously and uniformly mixed in the water.

And then as discussed earlier that it starts the like it destabilizes the stable colloid particles and then flocculation starts. So, for purpose of flocculation we provide flocculation Basin which can be buffered channel flocculator or paddle flocculators which are generally the mechanical type flocculator. We may go for combined flocculation and sedimentation process as well which is clariflocculator.

So, if we are going for clariflocculator later then we do not need a separate flocculator then it will be just like will be passing a sample through a flash mixture and then it straightaway goes to a clariflocculator system or otherwise in other hierarchy we will be actually like if this is the systems and then it will be going to flash mix then it will be going to a flocculation basin and then this goes to a sedimentation basin further.

But if you are providing clariflocculator so we do not need a separate flocculation basin because flocculation and sedimentation is mixed in one single unit.

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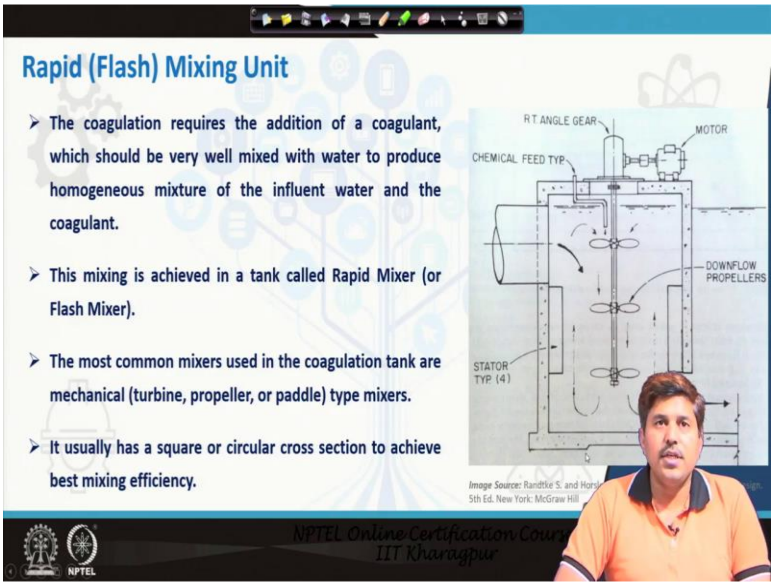

Now the rapid mix or flash mixing unit is essentially for mixing the coagulant with water so that a homogenous mixture is produced of the influent water and the chemical that we are adding. This mixing is typically achieved in a tank which is known as rapid mixer. This tank is typically known as rapid mixer or flash mixer generally because we intend to make something so we choose a shape which is which can have a good mixing which can ensure a good mixing.

So, either circular or square type cross-sections are used we do do not want to use very long channels over here because then mixing will not be proper or we need to provide more than one mixer that way. But instead what we do we choose the circular or square tanks where we can achieve good mixing. The most common type of mixers are generally the mechanical mixer. So, we may go for mixers which is like turbine type propeller type or paddle type mixer.

So, if you see here like if say this is the soft and will be having the propellers added to these and we through a motor we rotate it rapidly. We let the content in from one direction and it completely mixed and it leaves the system pretty quickly.

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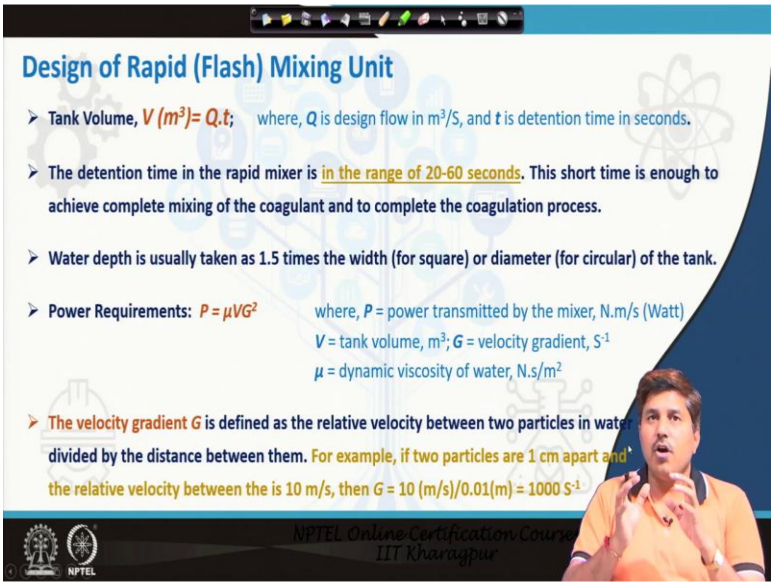

Now the point here is that the objective of a rapid mix is just mixing. So, as quickly as we can mix it would be good because our unit will be smaller. If we are mixing if you are taking say 10 minutes for mixing. So, we have to retain the flow for around 10 minutes for say and if we are say working with 1 mld flow. Let us say we are working with one mld flow. For 1 mld flow the 10 minutes would 1 mld means we are actually going to 1000 meter cubes per day.

So, 1000 meter cube per day whatever is the requirement like if we divide it by 24 and then 60 so whatever number we will be getting we need to multiply that with 10 minutes that would be the size. Now if we instead of 10 minutes we achieve that mixing in 1 minute. So, our size or the volume of the system is going to be one 10th of the one 10th of the size which would be needed for a 10 minute residence time.

So, we want for that practical purpose we want this to be like as fast as we can the mixing and that is why we use very low residence time or very low retention time in the flash mixture. Instead we increase the mixing speed and the time that we keep is very low. So, typically we do use residence time in the range of 20 to 60 seconds, so within 1 minute we achieve this mixing and for that purpose we need to mix it rapidly and that is why it is known as rapid mix or flash mix.

So, we know the discharge what amount we need to treat and if we decide a residence time let us say we are choosing that we want 30 seconds residence time or half a minute residence time so that way we can compute the volume where Q will be the design flow in meter cube per second and T is the time in seconds. Now the water depth is usually taken as 1.5 times of the width if it is square tank or 1.5 times of the diameter if it is a circular tank.

We need power for rotating the mixer so the requirement of power in a flash mix unit or for that matter in any other unit even this is the same for the flocculation Basin as well is the power requirement is mu V into G square where P is the power transmitted by the mixer V is the volume of the tank nu is the dynamic viscosity of water and G is the velocity gradient. Now this velocity gradient is one of the very important parameter for designing mixing basins where we want to ensure mixing.

Either a rapid mix or a flocculator or slow mix system, now this G is typically defined as the relative velocity between two particles in water so let us say we are having two particles in water one is moving say at certain velocity another is moving say at certain velocity the direction also could be different. So, it is basically the relative velocity between these two particles divided by the distance between them.

So for example if two particles are 1 centimeter apart so the distance between them is say 1 centimeter and their relative velocity is 10 meter per second then G will be 10 meter per second divided by 1 centimeter or 0.01 meter which is going to be equal to 1000 per second. So, unit of G is per second.

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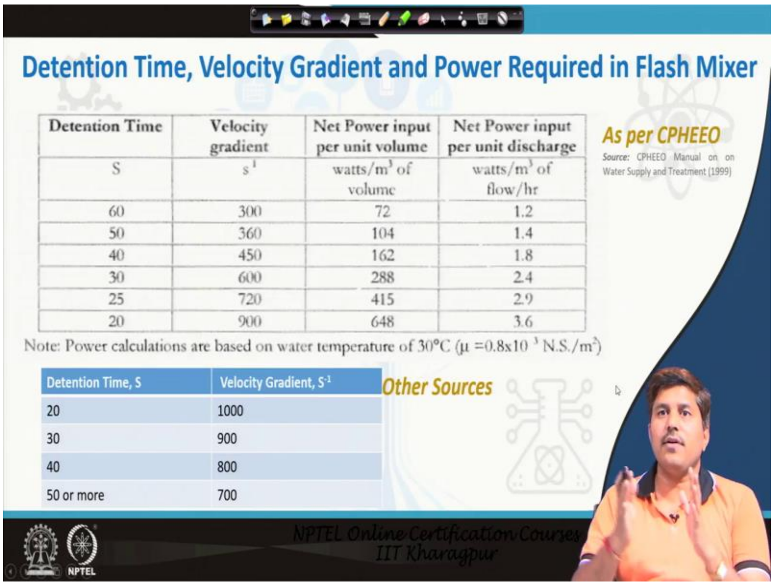

Now the G is important because it tells you that for unit distance what is the relative velocity between the particles so what are the chances of collision. The higher G value is the higher chances of particles colliding each other the lesser the G value the lesser the scale extent of mixing because then relative velocity of the particles is lesser and the chances that they will strike each other will also be reduced.

So, in flash mixture typically if we see the typical detention time 20 to 60 seconds we may choose the velocity gradient accordingly. If we are doing it at a low detention time so we need higher velocity gradient because we need more rapid mixing. If you are mixing it for one minute we can still get away with the slower mixing if you are just mixing for say 20 seconds we need further more rapid mixing so that the more turbulence can be created in.

So, typically like for 20 seconds we need a velocity gradient of around 1000 for 30 seconds 900 for 40 seconds or 50 seconds 700 but these are again the recommended values there is no like hard and fast guideline that we have to or there is no hard and fast scientific reason that we have to have minimum of this G value for say certain detention time. So, the different group of expertise or group of panels we may recommend different values.

Like the CPHU manual recommends these following values so first 20 they say that 900 should be the G value. For 60 it should be in the range of 300. The net power input per unit volume would be this much based on these detention time G values and net power input per unit discharge is going to be this much. So, we can see that how the power is required. Now of course if you are doing it for lesser time for 20 seconds the power required per unit discharge is 3.6 watts per meter cube.

Whereas if you are like doing it for 30 seconds it is 2.4 for 1 minute it is 1.2. So, the power requirement of course will be varying based on this.

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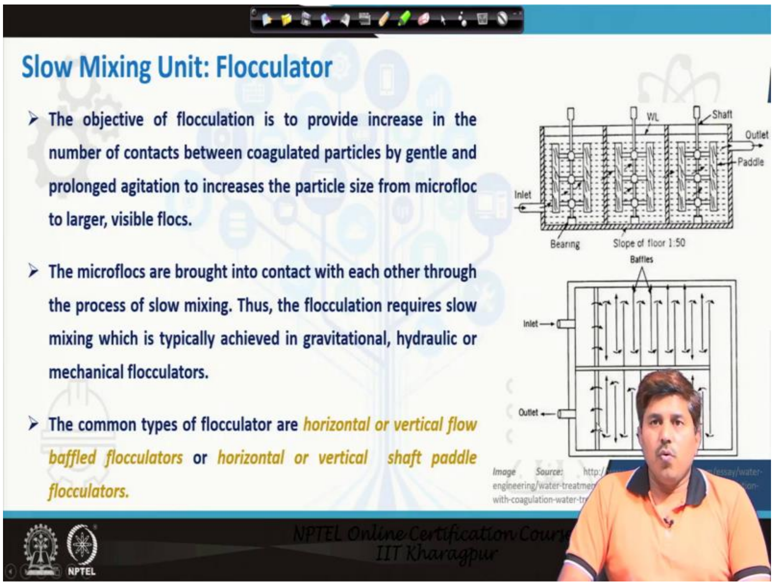

Overall the power that needs to be transferred has to be transferred if we are doing it in a say smaller times a per unit time the power requirement would be more if you are doing in a say larger time of course the relative power requirement would be lower. Now that was about the rapid mix. We need slow mixing units for flocculation purpose. So, the both here in both the cases we are talking about mixing only but the idea here of slow mix and rapid mix unit.

In the rapid mix our objective is to completely mix the chemical that we are adding no other objective. So, in whatever time we can do that it would be good. The objective of the flocculation is to provide increase in the number of contacts between the correlated particles and that can be achieved through gentle and prolonged agitation so that the paths the chances or the opportunities are particle interacting with each other should be good.

So it is not like we can do it in a very quick time or in a few seconds it needs some time and the rate of mixing should also be controlled here. If we are going to mix it very rigorously we will develop lot of shear forces in the fluid and as a result even if the particles are colliding each other they are not going to kind of form agglomerates or even the form diagram elates can be broken if the high in the if the shear forces are very high in the bulk fluid.

So, what is done here the micro floc's are brought into the contact with each other through the process of slow mixing and that is why the flocculation typically requires a mixing which is off slow of nature slower regime and this can be achieved by gravitational hydraulic or mechanical flocculator. The most common type of flocculator are horizontal or vertical flow baffled flocculator which are gravitational flocculator or horizontal or vertical shaft flocculator which are mechanical flocculators.

So in buffed flocculator will have water entering here and then will provide certain buffers and then flow regime ensures mixing where is in this soft pedal flocculator will have a shaft and pedals attached with that and then this as the shaft rotates the pedal will rotate and they will ensure the mixing in the system. So, that is the basic difference between these two.

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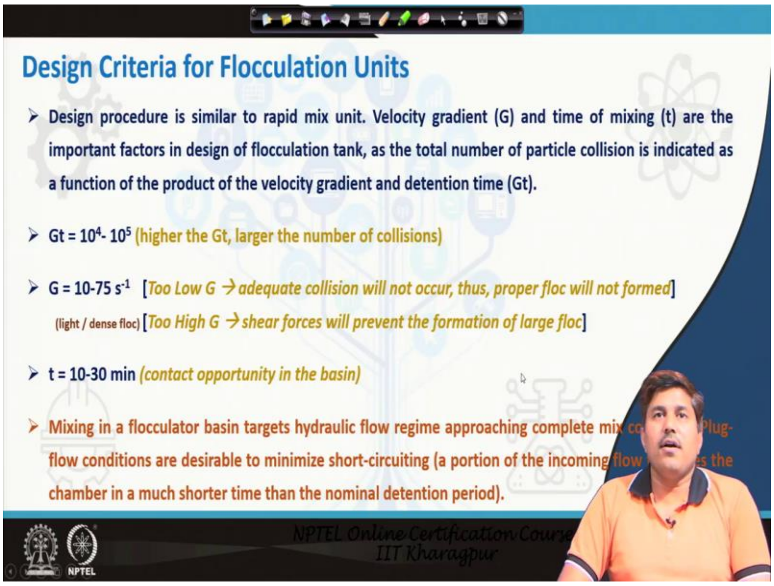

Now for designing the flocculation units the design procedure is similar to rapid mix we need to assume residence time and then based on the discharge we can actually get the volume of the tank. So, for say if we are if we are choosing 15 minutes or 20 minutes residence time so our volume will be Q whatever flow we are getting into the time whatever time we are choosing. So, this way we can determine the volume.

Like rapid mix we did talk about the importance of G, rather G is more important for a slow mixing unit. So, the velocity gradient and the time of mixing are the very important factors in the design of flocculation tank. Because the chances are the total number of particle collision is typically indicated by the product of these two functions which is G into T. Now typically GT ranges between 10 to the power 4 to 10 to the power 5 for flocculation units.

The higher the GT the larger than of collisions you can understand it that way because G is providing relative velocity or some sort of mixing like the scale of mixing and T is the time. So, at the same scale of mixing if we keep it at a longer time we are going to go for longer or more number of possible collisions or for the same time if we increase the G for say, so if we are working at a lower G where the relative velocities are low or the mixing opportunities are lesser to a higher G value where the relative velocities are high.

So, there the chances of the mixing or the num can says that the number of collisions that are going to happen in the system would be higher. So, it is GT which typically kind of decides what is the range for the number of collisions and typically GT value 10 to the power 4 to 10 to the power 5 are considered for flocculation basins. So, that we want to ensure the collision.

Now typically G value which is taken is in the range of 10 to 75 of course this is not again very hard and fast train some people even take up to 100. So, G values can be taken even higher than 75 but mostly it is in the range of 10 to 75. If we go for too low G value then what we see is that the adequate collision will not occur because if G value is too low that means the relative velocities between the two particles is too low.

And the possible the possibility of them colliding each other is probability of them colliding each other is also very low and as a result we may not see that adequate number of collision which is happening and then proper floc's will not be formed. If we go for higher G if G value is too high then again as we were just discussing that the shear forces will be very high and they might prevent the formation of the large floc's.

So even if the there is lot of collision happening lot of particle to particle interaction happening but because of the shear forces that are prevalent in the bulk medium will prevent the formation of the large floc's even the large floc's which I found may also get like defragmented. So, that is the risk of having too high or too low G values and that is why it is very important for process control of the flocculation that we maintain an appropriate G level.

Typically time which is given between 10 to 30 minutes which is contact opportunity in the machine and again this is also not very hard and fast value we may see certain fluctuations in these numbers. So, particularly on higher side so a few basins go for time more than 30 minutes. So, mixing typical mixing in a flocculator Basin targets the hydraulic flow regime which kind of looks for complete mixed condition.

So, in a flocculation basin because it is important for the fluid to spend that this much amount of time at say certain mixing regime. So, we want that there is adequate amount there is adequate level of mixing happening in the basin and at the same time we also want to ensure that the fluid is spending same substantial time or design time in the basin. So, for that reason we do not want any sort circuiting we want to minimize the short circuiting.

What is short circuiting? Short circuiting is let us say if you are having a chamber like this and if you let the fluid come in and fluid go out from here so what happens there might be some dead zones created because the fluid may take a path like this or some fluid may take a path like this so ideally the time they should spend some portion of the fluid will spend lesser time where the fluid that are in the dead zone will spend much more time because they are in the dead zone.

So almost they are not as a component or in the active volume of the tank and then active volume reduces. So, the remaining fluid particles or remaining fluid mass will spend lesser time. So, this is known as the short circuiting when basically it finds a way to leave the system quickly we want to minimize the short-circuiting and for minimizing short-circuiting the plug flow conditions are preferred.

A plug flow condition is as we discussed earlier also that a fluid basically is moving in a kind plug kind of thing and it is following each other. So, there is no possibility of any fluid retaining in the tank and it is practically following like one plug is following the other plug, so the fluid is flowing in the plug flow kind of regime. And this plug flow regime is very good in the baffle system.

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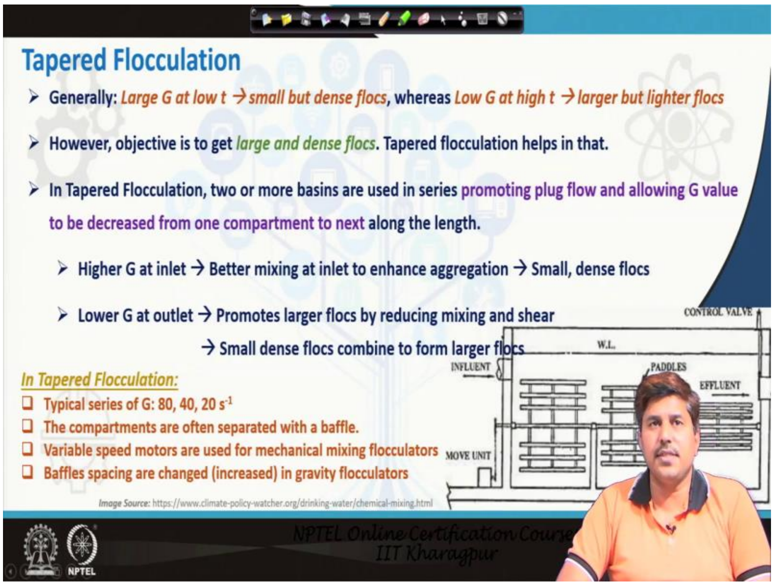

So, as just we were discussing that the G and T are the very important parameter for the purpose of the flux formation how good the floc's are going to be formed. Now if we operate the system at large G and low T will get small but dense floc's. As we said that we want to fix GT in certain range say 10 to the power 4 to 10 to the power 5 now there are two options we have high G values and low T values or high T values and low G values relatively.

In both the cases there are certain issues like when we are working at large G and low T value will get small floc's but dense floc's. Low T means the time that they are getting is smaller so the floc's will not go grow big and the large T large G value means there is higher opportunity of collisions. So, the floc's that will be coming in the tank will be quite dense. So, we are going to get dense floc's but they do not have enough time to grow big.

If we work at low G and high T values then that means we are going to go for a larger floc's but they will be lighter because of the G values are low so when they are striking the relative velocity is not that high so the floc's that are going to form are not very solid. So, they are more fluffier kind or lighter kind of flow and but because the fluid is there for higher time so the floc's will go on floc's will grow bigger and as a result we are going to get larger or bigger floc's but they are going to be a lighter.

Ideally the best condition for us would be large G and dense floc's. Now large G and dense floc's one way is to achieve that we increase the G we work it at a high G value and high time. So, that but in that case we are going to get very high GT value and as a result we will probably require more energy also. So, in order to work out another alternative the tapered flocculation is also used for this process. Now the tapered flocculation is that we have two or more basins in series so we may like water coming in here and we may have say 3 basin in then 2 basin then 3 basin and then what are leaving out.

Of course it is not that way so we have 2 or 3 basins and they are arranged in a series now this what these basins do but water when water is coming here and then here and then here so first thing is that it is ensuring a better plug flow. And the second opportunity provides that we can change the G value from one compartment to the another compartment or residence time from one compartment to the another compartment.

So, how typically we do we keep high G values at Inlet, so that at inlet when the water is coming into the system we provide better mixing and there are better chances of aggregation, so we get small and dense floc's of course the time will be less so the floc's will be smaller but they are going to be dense floc. And then as we move like in the downstream direction so we reduce the G value. So, in the next tank wheel working will work at lower G value at the outlet will be actually working at the lowest G-value.

So when we work at a low G value so what it does it and particularly like it is getting more time so it will promote the larger floc by reduce the mixing and shear when we are working at low G value show the shear force will be lesser. And as a result when they come into the contact these are the small floc's small dense floc's which has formed they will come into the contact and as a result the they will combine to form larger floc's.

So what will happen that these small dense floc's will combine to form a larger flock. So, we will get a large size of flock and with a good density as well. So interpret flocculation we like use G values in series like 80, 40, 20 that kind of values we use per second. We can separate these compartments with a baffle channel or with a basically partition wall or baffle wall. We may use variable speed motors so that we can change the speed also of mixing and so far we can change the G value as per our requirement.

If we are going for gravity flocculation so we can actually change the spacing between the baffles. So, the different spacing between the baffles can be changed or we can like the paddle sizes also we can change so the kind of larger size paddle wheel or more number of this is going to provide more mixing. Whereas towards outlet will have a lesser spacing so that the scale of mixing is reduced that kind of tapered flocculation can be used.

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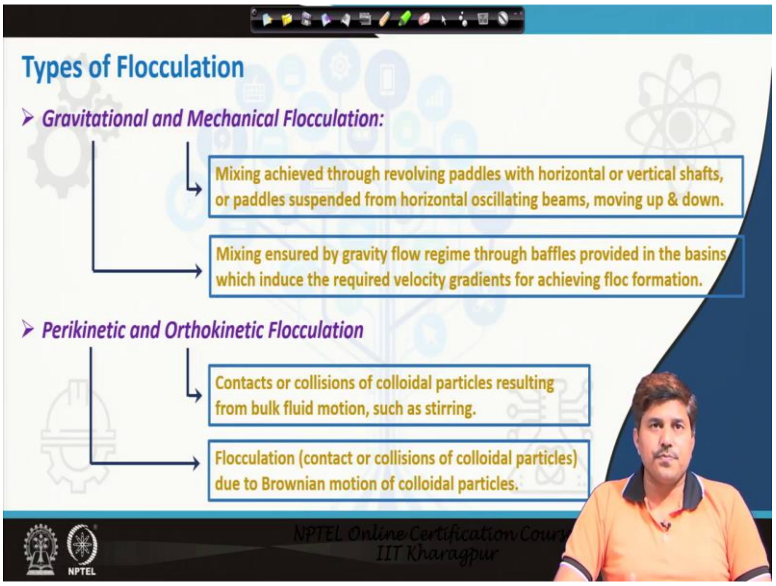

Now there are gravitational and mechanical flocculations as we were discussing. So, gravitational flocculation is when we ensure mixing by the gravity flow regime and for that purpose we provide the baffles in the basin which kind of induced the required velocity gradient for achieving flock formation. Alternatively in the mechanical systems we provide the revolving paddles with horizontal or vertical shafts or we can actually suspend paddles with horizontal oscillating beams moving up and down.

The other type the other criteria for like deciding the type of flocculation could be what kind of kinetics it is following so there are orthokinetic flocculation and perikinetic flocculation. The orthokinetic flocculation is the one which we mostly ensure in the in the flocculation basins where the contacts or collision of the colloidal particle result from bulk fluid motion such as when we are putting a staring system or that kind of system.

The perikinetic is the flocculation which happens due to the Brownian motion of the colloidal particles. So, even if we are not mixing the Brownian motion of the particles will lead them to like collide but again if the particle size grow on bigger so then they will not be moving that frequently. So, the perikinetic flocculation cannot ensure very big floc’s, so for that purpose we need orthokinetic flocculation.

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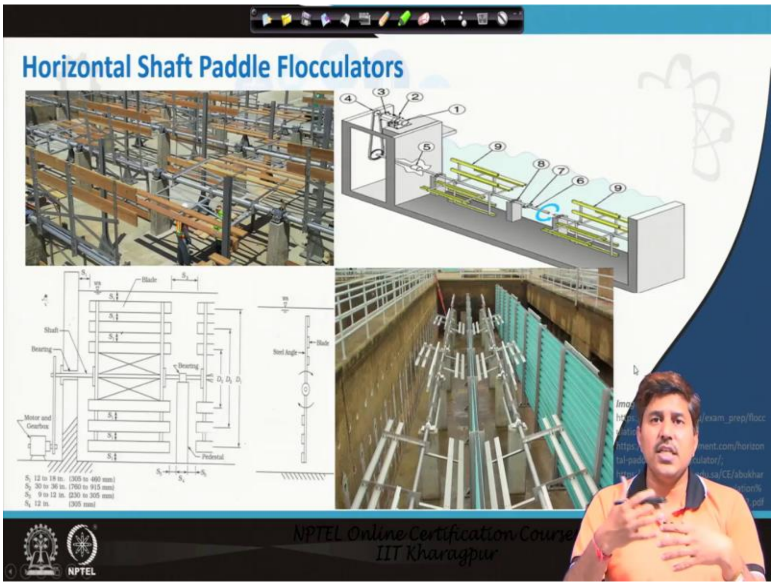

But by nature of the compound or colloid it says there will be under Brownian motion the colloids do Brownian motion like moments. And so the initial for flocculation may actually be resulted from the perikinetic flocculation as well. So, as we are discussing different type of flocculation. So, we have horizontal shaft and paddle flocculator 's like this, so the working is simple what we have is a horizontal shaft and then there are like paddles attached to this and these paddles rotate in the basin.

So in real it will look like this we have this say this is a divided this thing this is one soft and through these the paddles are attached and these paddles keep on moving. So, it could be like if we see the plan and section that way so from this view it will look like we have a shaft here and then these are the blades attached to that the range of spacing can be this much a real basin when may look like this. So, this is horizontal soft-pedal flocculator. The next one is the vertical soft-pedal flocculator.

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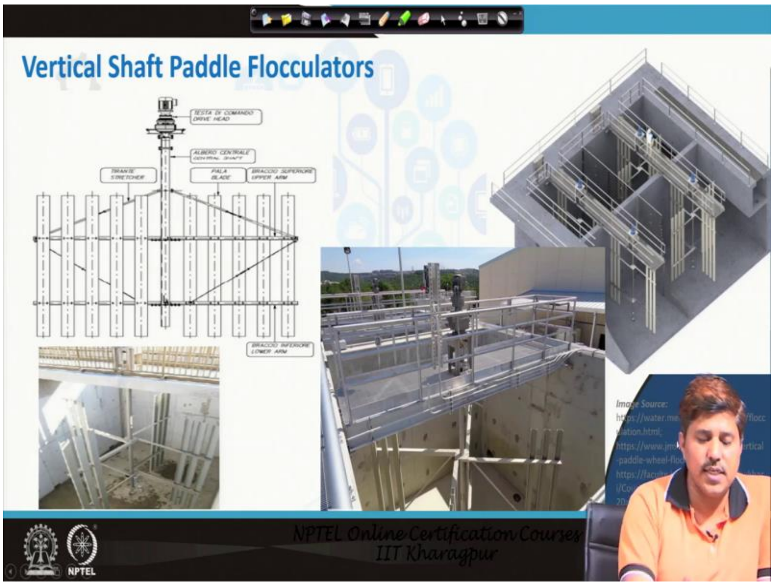

Which is which is like this so we have a vertical shaft and similarly like in the horizontal shaft we have that the shaft is horizontal and the pedals attached to this and they revolve like this. Whereas in vertical shaft the shaft is vertical and then pedals attached to that are vertical so, it would be like say this is a real basing picture so we have a word vertical shaft and then pedals attached to this and they get a rotation like this. So that way they ensure the mixing in the system.

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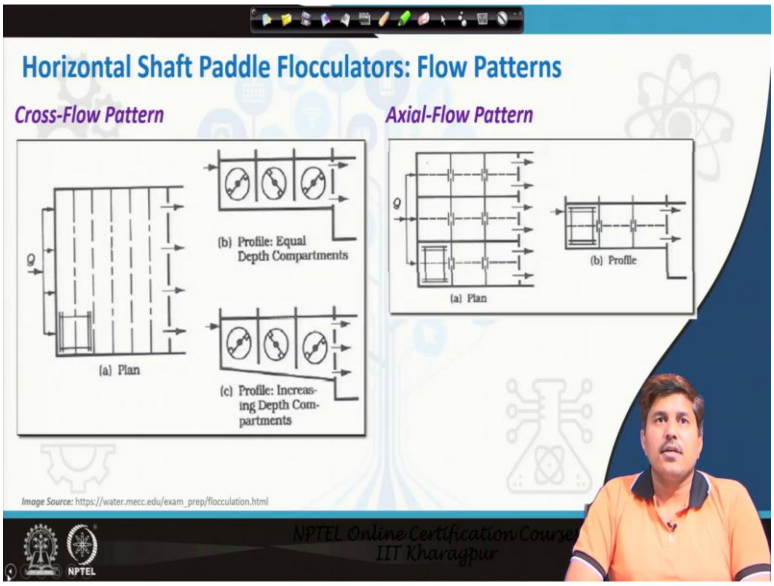

The horizontal soft-pedal flocculator can be can follow cross flow pattern or axial flow pattern ok. So, the cross flow pattern is when we have say say this is our soft say this is our soft and we have pedals attached to this. And flow is taking place in this direction, so this is a cross flow pattern because flow is taking place in this direction and the pedals rotation is the in the cross direction. So, this is the direction of say flow and this is the direction of pedal rotation.

So, it is basically at the right angle of this whereas axial flow is if we have a shaft like this our soft is also like this and the flow direction is this and the pedal rotation direction is also this. So, the rotation of pedal or the axis through which the pedals are rotating is actually in the same direction of the flow, so that we call axial flow pattern and if the axis through which the pedals are rotating is in the right angle direction of the flow 90 degree to the flow then we call that as a cross flow pattern. So these are the 2 type of patterns which are followed in the;

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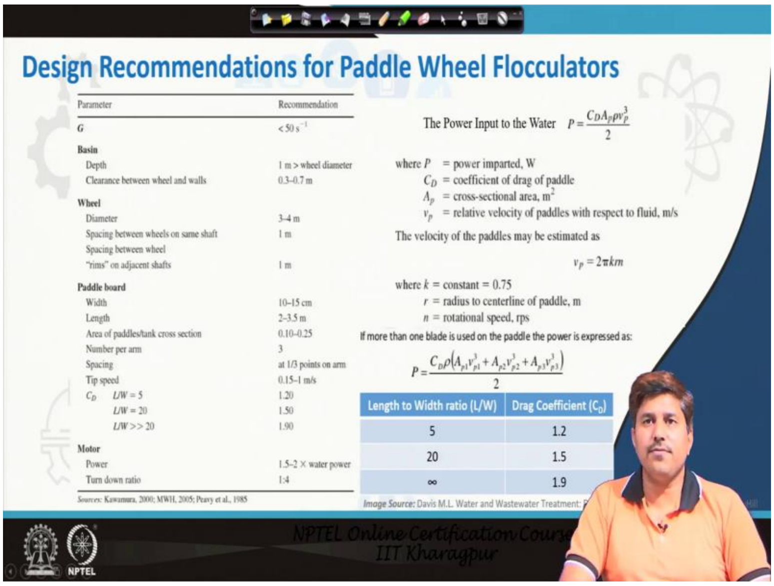

This is more important for the horizontal flow regime because in vertical flow regime we do not have any such the flow is always vertical and the movement is vertical. So, in either direction flow comes it is going to be the same but for horizontal soft-pedal flocculator this is important the cross flow one gives the better mixing as opposed to the axial flow ones. These are some of the design recommendations for paddlewheel flocculator so G value is typically taken less than 50 per second.

The depth is greater than one meter and which should be greater than the wheel diameter of course. The clearance between wheels and walls is kept between 0.3 to 0.7 meter the spacing for V is the pedal boards the motor that like we follow these recommendations. Again this recommendation also varies from source to source but typically like it is there in this range. The power input to the water can be computed as CD A P Rho V P square A V P cube by 2 where P is the power that needs to be imported CD is the drag coefficient which depends on the length to width ratio of the blades pedals.

So, it is typically can be taken in this range and if we are using more than one blade on the pedal then the power that is going to be is equal to CD into Rho and in this component A into VP cube is taken as sum A into VP like for first blade second blade third blade. So, we need to sum all these that way it can be done. AP is the cross sectional area and VP is the relative velocity of the particle with respect to the fluid.

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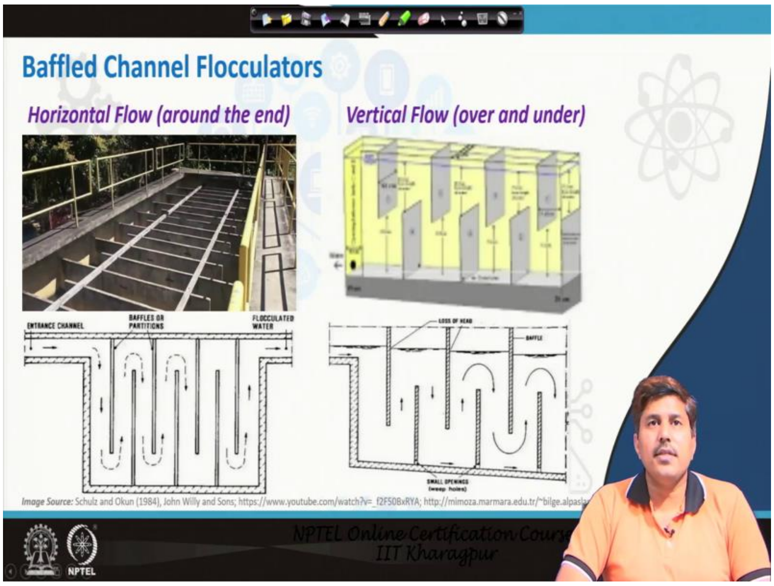

Then there are baffle channel flow flocculator’s so there are horizontal flow flocculator and a vertical flow for vertical flow baffle flocculator. So, in horizontal flow flocculator the direction of like the flow is hot the baffles are horizontal. So, the flow is say coming in like this and then it will be moving so we have placed the vertical baffle like this. so, flow direction of flow is horizontal if you can see this so the flow is coming from here then it is going there and it is closed from one end and open at other end.

So this flow will take a move from here and then again it will go it it is closed here. So, it cannot directly go it will actually be moving like this so this kind of arrangement ensures pretty good the plug flow conditions. Because once the fluid is released it is following the other plugs that are flowing there. There cannot be any dead zone in this kind of systems usually so that way this is basically the flow happens around the ends, so this end and that end and this end and that end so that way it will be going and this the velocity is such that it actually ensures the minimum level of turbulence in the water.

Not minimum means it is not static but ensures the minimum level of turbulence which is needed for mixing purpose that is ensured in the system. Then the vertical flow which are over or under these are relatively lesser used type. So, here we have like baffles over and under and then flow vertical baffles we have and then flow takes vertically. So, it will first go down like this and then it will be moving up. So, in a real channel it will the flow direction will be this and then it will it is open from here.

So, it will find up a path over here it will go again it is closed from the top so it will find like the flow will find and again have to come down then have to go up then again have to come down. So, if the flow takes place over and under, these baffles, over the over these buffers and under the baffles which are put at the top. So, the flow direction is vertical either like a downward or upward whereas here the flow direction is typically horizontal. So, that is why these are called horizontal flow and these are called vertical flow baffles.

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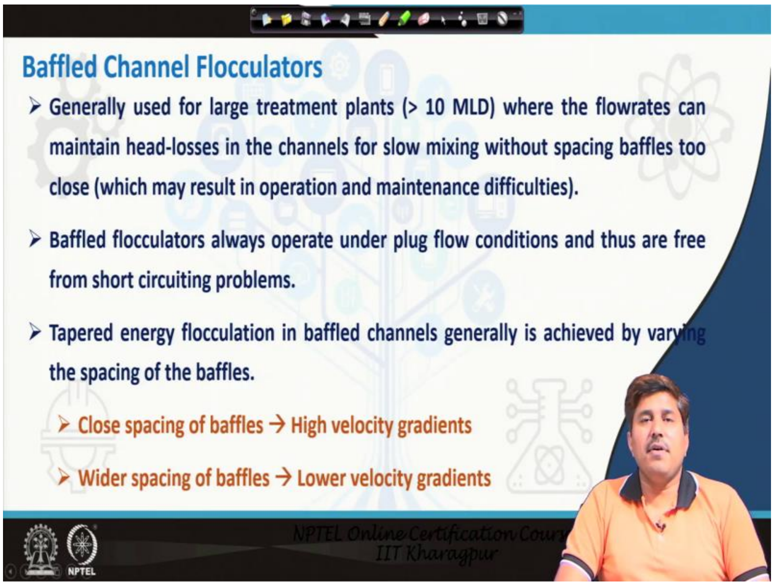

The baffle channel flocculator is typically used for treatment plants which are of size greater than 10 mld for smaller treatment plants also some people use and more so ever like we must see whether it is feasible to go for a baffle flocculator or for mechanical flocculator. The for minimum flow rate is needed because we want to have a minimum velocity through this otherwise if the velocity is too low then there is possibility of settling taking place in the system itself.

And then opportunity of the collisions will also reduce, so we want to ensure the minimum velocity in the system a so that this desired slow mixing is ensured and for that we need to space the baffles at appropriately. Now if the flow is low if Q value is low the spacing of baffles required to like require to maintain the minimum velocity can be very close and in that case it is going to be difficult for operation and maintenance purpose.

So, that is why we do a wide baffle channel flocculator for low flow regimes. The TP always operate under plug flow condition so there is no short-circuiting problem if you are spacing the baffles closely then we are going to get high velocity gradient higher G values. If you are spacing the baffles wider we are going to get lower velocity gradients. Of course the like we know that the Q is equal to V into a so the cross sectional area if you are spacing the baffles wide cross sectional area is more so velocity will be less or the velocity grid gradient will be less.

And if you are spacing baffles closely then cross sectional area reduces the velocity will be increased but again as we said that there might be operational difficulties.

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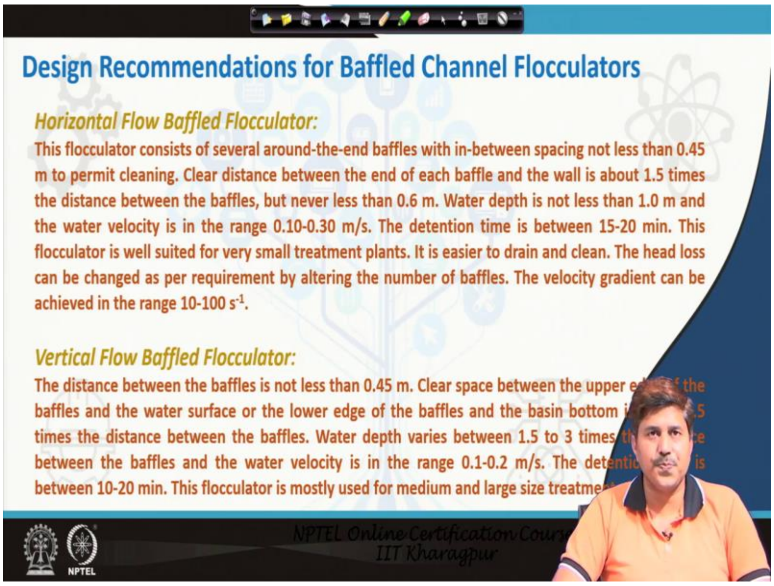

These are some of the design recommendations for buffer channel flocculator. These are taken from the CPHU manual. So, this provides the various essential information's as such like what is going to be the what is going to be the like spacing between the buffers the range of the velocity the detention time what are depth for horizontal flow as well as for vertical flow flocculator.

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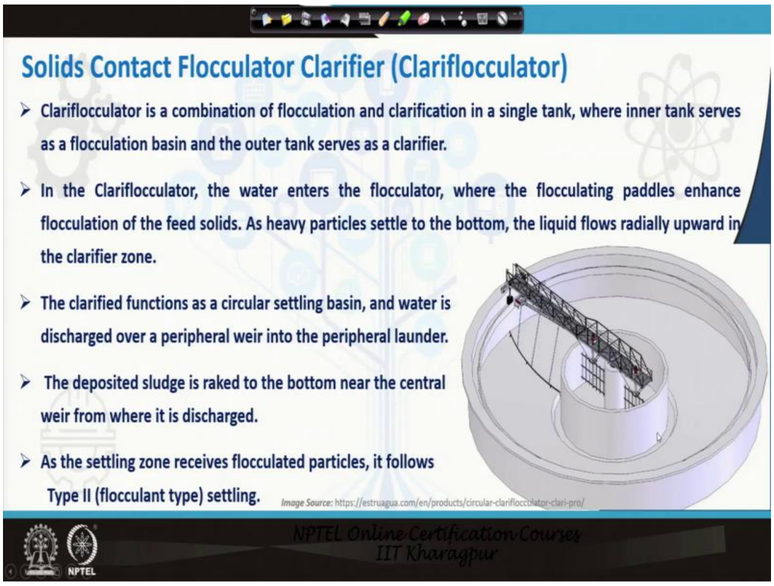

For vertical flow flocculator's it is basically like it is advisable to kind of see the energy consumption required because the head losses are likely to be higher because of the flow ugh against the gravity might be taking place. Then there are clariflocculator's which are the solid contact flocculator clarifier as we were just discussing in the beginning of this class as well that the Clariflocculator is actually a combination of the flocculation and clarification basin.

So we do have flocculation and clarification both the process happening in a single tank and inner tank here serves as a flocculation basin and the outer tank serves as a sedimentation or settling basin. So, what happens water comes in the center and then we have a flocculation be working on here and then through baffles or through underflow generally through under flow water comes in the in the next zone which is actually our settling reason or clarifiers zone.

And then sedimentation takes place here so the water enters in the flocculator where populating paddle kind of works and then the flocculation will be achieved after that it will go to the clarifier reason and then clarification process will be happening. We do have kind of a mechanism to push the solids again to the center and from there we can collect the solids and the water will be basically going through the peripheral veers.

So water can be collected or the treated water can be collected through the peripheral launders. The type of settling here is usually tied to settling which is flocculent type settling because Clariflocculator is essentially design and particularly the settling zone is designed to settle the flocculated particles because we already have a flocculation basin. So, we assume that the particles or the material that is entering into the clarifier zone is the flocculated particles.

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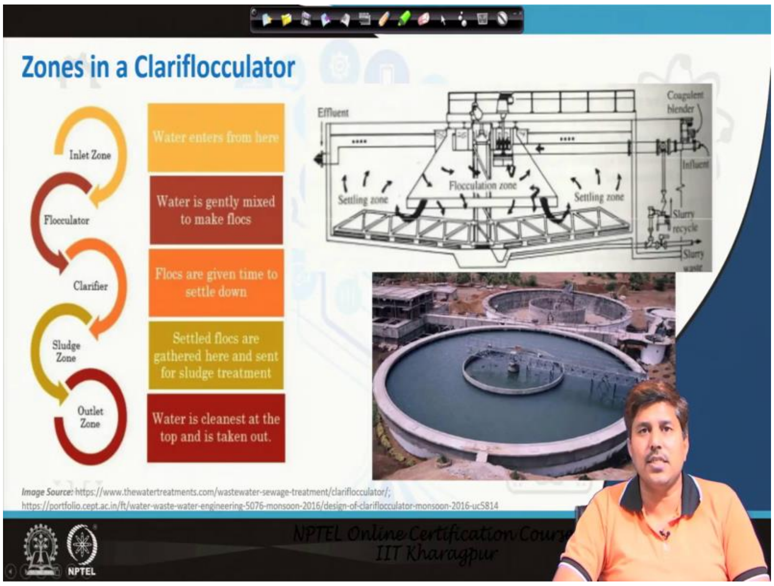

So we would be basically seeing a type 2 settling which is flocculent typesetting and discrete settling is not that common in the Clary flocculator it it will never be actually again similar to the settling basin there are different zones in the Clariflocculator as well there will be inlet zone there will be settling zone there will be a sludge zone there will be outlet zone. In addition we have a flocculator zone. So, inlet zone where water enters flocculator where water is gently mixed to kind of make floc's.

So as the water enters generally from the center so it will first go to the flocculation zone and then it goes to the clarifier zone which will be kind of looking like this from the top. So, this is like this is a real basin so you can see that here it is this is the flocculation zone and this is the clarifloccutors zone and through the periphery launders the effluent will be collected so we will have the outlet zone at the periphery and the sludge zone at the bottom of this here.

So, that way we can actually get the like we can see the different zones in the Clari flocculator there are like different type of Clariflocculator as well. Those are like if we see the different type of Clariflocculator. So, the type of Clariflocculator are decided based on what like how is the what is the length of this. What is the length of the bridge and the other mechanism is where from where we are actually controlling the movement of this.

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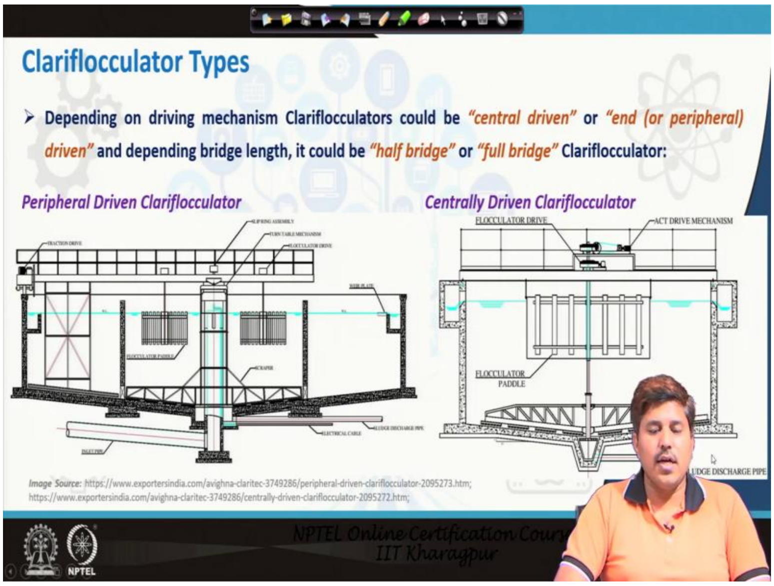

So, these are the two things which kind of decides so based on this the Clariflocculator could be central driven when we are actually like deriving it from the central so the derive mechanism is placed at the center or it could be the end driven when the derive mechanism is at the end. So, when it is at the end it actually moves through all through the periphery and when it is the center it is actually fixed at the center.

And then from Center it rotates the entire truss again the movement is throughout the peripheral because we need to collect sludge and those things scrapper. The other thing is the bridge length. So, we may have a half bridge Clariflocculator. This like this is a half bridge clariflocculator. The bridge length is half and here we may have a full bridge we can consider this as a full bridge clariflocculator because the bridge length is the of equal to the full dia actually touching both the edges of the clarifier at any given point of time.

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The design procedures are actually the Clariflocculator Tsar designed following the design principles of the mechanical flocculation basin for inner path and circular sedimentation basin for the outer part. So, it is simply like those design principles are followed. For flocculator we have certain design criteria again these numbers are just from one single source the different manual or different guidelines may recommend different values.

So, we may have the like depth of tank the detention time in the range then inlet velocity gradient all these different design criteria's are given for the flocculator for the clarifier and for the sludge hopper. So, this may be used for designing a Clariflocculator. The principle that we are going to follow is for like the inner parties of flocculation basin. So, it will be exactly designed as a flocculation basin and then the outer part is the clarifiers it will be exactly designed as a clarifier.

Only thing that we ensure for but particularly the circular because the clarifier is the circular so, the effective daya of the clarifier let us say if we are having say we have inlet pipe around this we have we have a flocculated zone. So, when we are getting the area of the clarifier zone the required area for the clarifier zone. So, the required area it is simply not going to be equal to pi d square by 4.

But because there is an inner part in d, so it is going to be like the outer area which is say the outer daya is do per se so pi do square by 4 is the outer area and the inner area or the area of flocculator is also there. So, let us say if the daya of the flocculator is d or says so then pi d square by 4 or is the area of the flocculator. So, from the total area pi d square by 4 - pi d square by 4 or we can say the PI by 4 do minus do if the die of the flocculator is this so do - df square this has to be equal to the clarifier area.

So, we will be taking an example probably in the later class and then that will be more clear but that is how that is the point that we need to keep in the mind. So, we will conclude the discussions on the cognition flocculation process here and of course we will be taking some example problems later in a later class but the discussion part we are closing here. And then in the next class we will start discussing about the filtration process. So, see you in the next class thank you for joining.