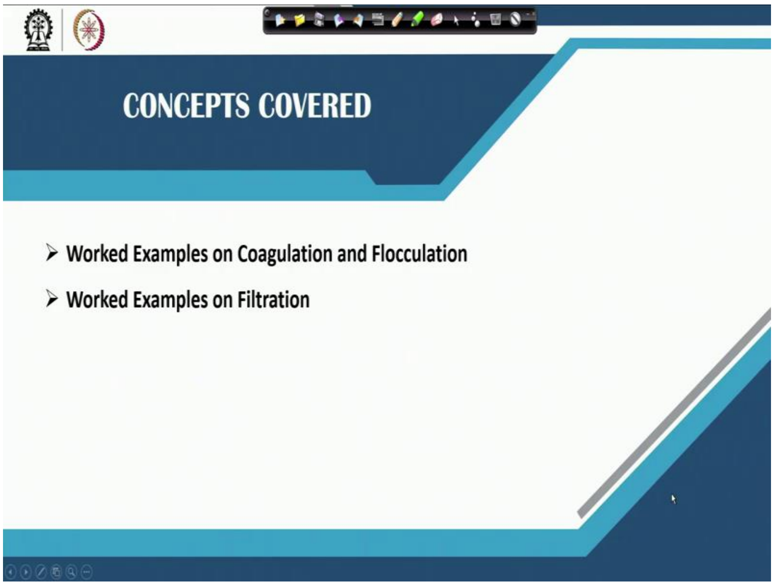
Water Supply Engineering
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture-34
Practice Problems (Coagulation Flocculation and Filtration)

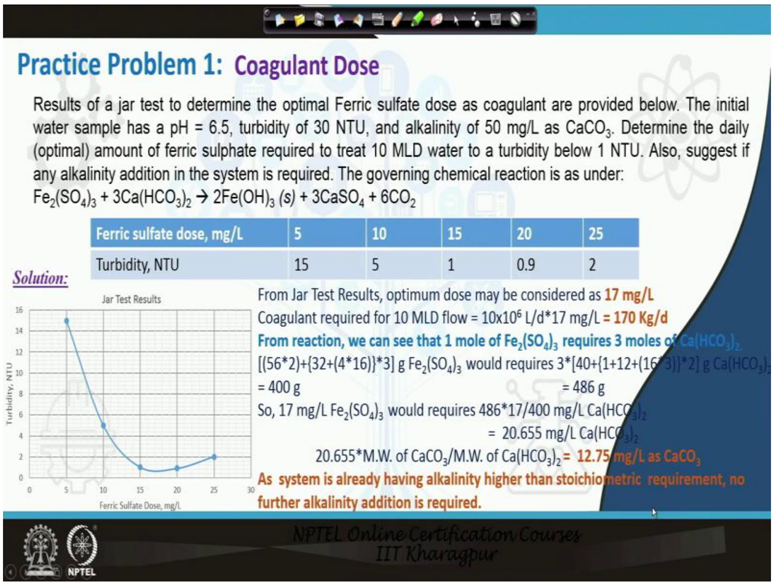
Hi friends and welcome to this last class for this week, this has been a long week instead. So, we have been discussing about the coagulation flocculation and filtration processes this week.

(Refer Slide Time: 00:33)



And in this particular class we will be taking some practice problem on whatever we have discussed so far in the week. So, practically what we are going to see some worked example on coagulation and flocculation and some examples on filtration processes.

(Refer Slide Time: 00:41)



So to begin with the first problem that we are going to discuss is on the coagulant dose. The problem statement is say the results of a Jar test to determine the optimal ferric sulphate dose as a coagulant are given in the table. So, we have been provided these doses in the table so at different like 5 10 15 20 and 25 ferric sulphate doses we have been given the different turbidity values measured. The initial water sample as a pH of 6.5 turbidity 30 NTU and the alternative 50 milligram per liter as CACO3.

You need to determine the daily optimal dose of ferric sulphate required to treat 10 million liters per day water to a turbidity below 1 NTU. Also we need to determine if any alkalinity addition is required in the system. The governing equation is also been given to us. So, this is a Jar test result and as we discussed while like deliberating on the Jar test, so, what we see here in a jar test we can plot the dose versus turbidity.

So, this is the plot of the Jar test and those versus turbidity these are the values like like at 5 we have the turbidity 15, 10 we have the turbidity 5 then 15 we have turbidity 1, 20 we have turbidity is 0.9 and 25 we have turbidity as 2. So, from this what we can see here that optimal dose is somewhere here this is the lowest point which is kind of giving us the value. So, this can be say considered as 17 so from Jar test result we can see that optimum dose may be considered as 17 milligram per liter of the ferric sulphate.

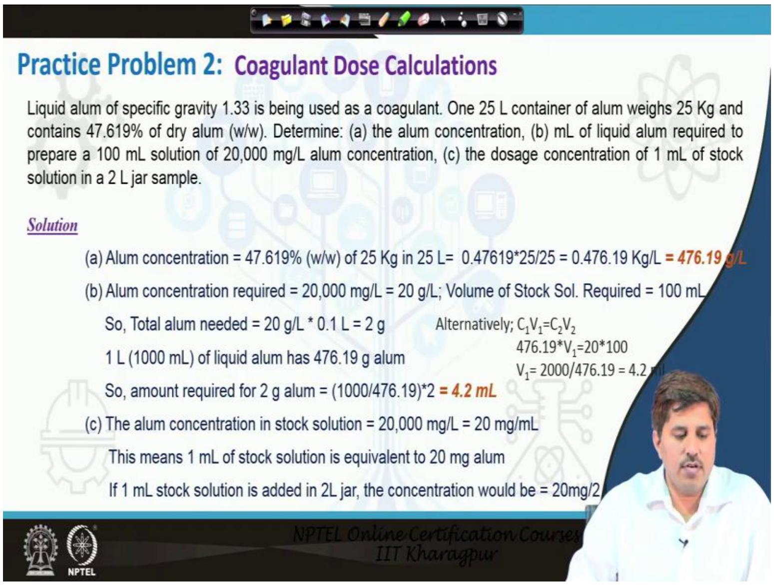
So, coagulant would be a coagulant requirement for a 10 mld flow so for 1 liter we need 17 milligram, so for 10 million liters means 10 into 10 to the power 6 liters per day will be we need to multiply this with 17 milligram per day and what will be getting is 170 kg per day is the requirement of the coagulant. We also need to test whether there is adequate element a present in the system or we need to add alkalinity. So, for testing that the reaction is given to us.

And from this reaction we can see that 1 mole of ferric sulphate reacts with 3 moles of the alternative, so 1 mole of ferric sulphate would require 3 moles of alkalinity, so the molecular weight of this sulphate is 400 grams molecular weight of the alkalinity as in like 3 moles of alkalinity for 86 grams. So, that means that like 400 grams of the ferric sulphate would require 486 gram of the alkalinity and now this alkalinity is as a CA CO3 whole twice.

So 17 milligram per liter what we need essentially would require how much would require this into 17 by 400. So, essentially it is the requirement is going to be 20.665 milligram per liter as calcium bicarbonate. Now the alkalinity is usually expressed in terms of milligram per liter as a CACO3. So, we will convert this as a CACO3 so for that purpose this into molecular weight of CACO3 divided by molecular weight of calcium bicarbonate this turns out to be 12.75 milligram per liter as CACO3.

So our final alkalinity requirement is 12.75 milligram per liter as a CACO3 we already have 50 milligram per liter as a CACO3 alkalinity, so we do not need any further addition system is already having sufficient alkalinity and that is why no further additional alkalinity addition is required in the system. So, that way we can estimate if say the alkalinity values was a 10 milligram per liter in that case we need to add extra alkalinity of 2.75 milligram per liter per se.

(Refer Slide Time: 05:09)



So, the next problem we have on carbon dose calculation the problem is that liquid alum of specific gravity 1.33 is being used as a coagulant, one 25 liter container that weights 25 kg contains 41.619% of dry alum we need to determine the alum concentration in this solution we need to determine the ml of liquid alum that would be required to prepare a stock alums solution of 20,000 milligram per liter concentration and 100 ml solution that we need to prepare.

So how much ml of that liquid alum would be needed for this and then the last part is we need to determine the concentration if we dose 1 ml of stock solution in a two liter jar sample. So, the first part is to determine the alum concentration now the alum is 47.619% weight by weight of 25kg. So, if we multiply 0.47619 into 25 kg this is the total alum weight which is available in 25 liters, so this is the weight and this is available in 25 liters, so that way we can actually like estimate that it is coming out to be 0.47619 kg per liter and 476.19 gram per liter is the concentration of alum in that particular.

So, that is the answer for the first part the second part is we need to prepare a 100 ml solution of 20,000 milligram per liter alum concentration. So, 20,000 milligram per liter means 20 gram per liter and the total solution required is 100 ml. So, like in 1 liter we need 20 gram so in 100 ml we will be needing 20 gram into 0.1 liter 100 ml which is essentially 0.1 liter. So, we will be getting total of; we will be needing total of 2 gram of alum to be added.

Now the solution that we have thousand ml means 1 liter of that contains 476.19 gram. So, how much solution is needed for 2 gram this much gram is available in 1000 ml, so one gram will be ml in 1000 divided by this number for 476.19 this much ml and 2 gram would be available you further multiply it with the 2. So, total 4.2 ml will be needed, this can be done in a simpler way also. We can use the C 1 V 1 is equal to C 2 V 2.

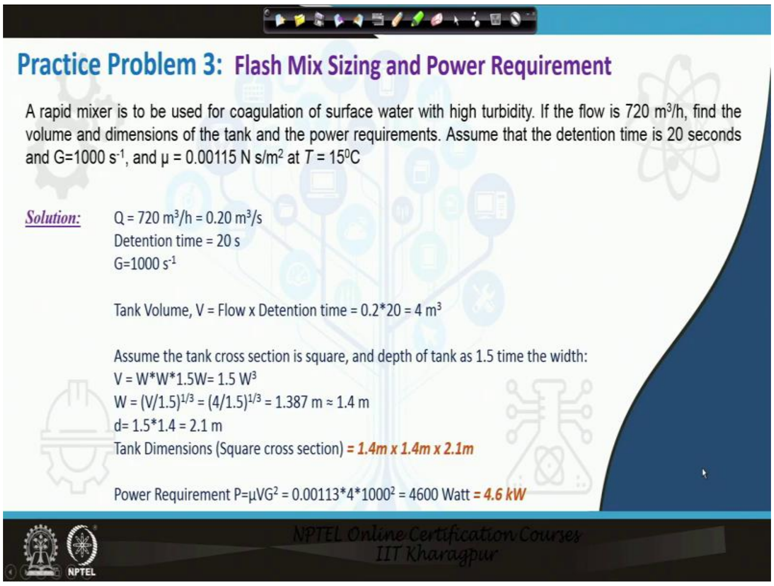
So the thing is that let us say we have two systems over here one that we need to prepare, so this is our existing system here we know that the concentration is 476.19 gram per liter, here the concentration that we need is 20 gram per liter the how much amount we need to take here this is we need to determine how much amount we need to prepare this is 100 ml right. So, C 2 into V 2 is 20 into 100 ml C 1 into V 1 C 1 the value we know gram per liter units are same. So, V 1 we can determine directly from here.

And that is coming to 4.2 ml so same answer. So, we can use this concept also it is in essentially the same thing just calculation is in a different way. The next part is the alum concentration in stock solution. So, when we add 1ml stock solution in 2 liter jar what is going to be the concentration right. Now the stock concentration is 20000 milligram per liter that means 20 milligram per ml.

1 ml consists of 20 milligram of alum, so if we are adding 1 ml of stock solution that means we are adding 20 milligram of alum and this 20 milligram of alum we are adding in 2 liter jar.

So, 20 milligram in 2 liter that means 10 milligram per liter is the concentration. So, that way we can get the answer for this part as well.

(Refer Slide Time: 09:23)



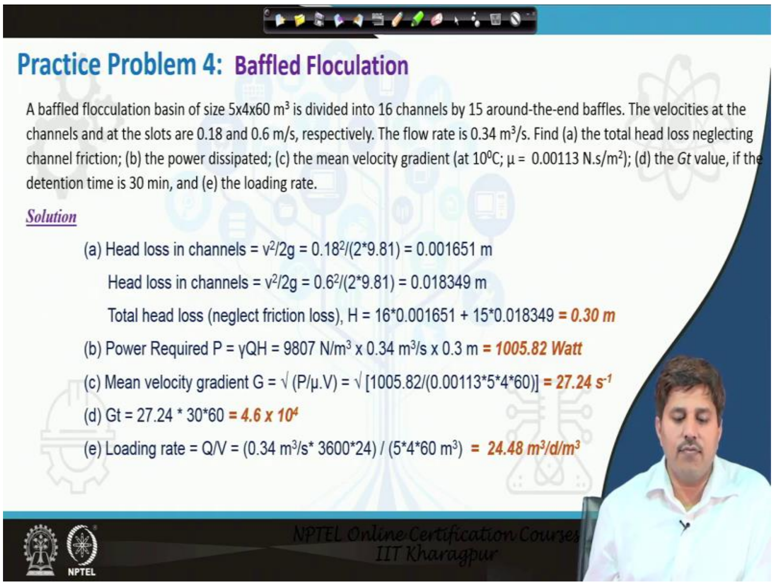
Now let us move to the next question which is on a flash mix system how do we size the flash mix system and what are the power requirements for that the question is a rapid mixture or flash mixture is to be used for coagulation of surface water with high turbidity. The flow is 720 meter cube per hour we need to find the volume and the dimension of the tank and the power requirements.

Assume that the detention time is 20 seconds G value is 1000 per second and mu value is also given at the given temperature all right. So, discharge is given 720 meter cube per hour which is equal to 0.2 meter cube per second. So, the tank volume will be flow into detention time flow is 0.2 and detention time is 20 seconds. So, this is 0.2 meter cube per second this is 20 second if we multiply we get 4 meter cube as the volume.

Now tanks are like as we discussed the flash mix tanks are usually taken either as a square or a circular. So, let us say if you are taking a square tank then we can assume depth as 1.5 times of the width so the total volume is going to be length into width into depth. Now length and width are equal so we can say W into W and depth is 1.5 times of that W so 1.5 W. So, this becomes 1.5 W cube the volume.

Now this 1.5 W cube is equal to 4 so the W value we can estimate from here the width is 1.4 meter. So, one edges of the tank is going to be 1.4 meter and depth is going to be 1.5 times of this which is say 2.1 meter. So, the tank dimension is going to be 1.4 meter into 1.4 meter into 1.2 meter that way we can put our tank. The power requirement P's mu V G square as we discussed, now the mu is given to us volume we know and the velocity gradient is the 1000, so we can compute the power requirement which is 4,600 watt or 4.6 kilowatt. So that way we can estimate the power requirement as well.

(Refer Slide Time: 11:42)



Let us move to the next question which is on the baffle flocculation so this is there is a flocculation basin of size 5 into 4 into 60 meter cube the volume is given to us which is having a 16 channels by 15 around the end baffles. So, we have a tank where there are say 15 baffles around the end baffles and that is leading to say 16 channels. So, we have total 1 2 3 4 5 6 that with 16 channels separated by 15 baffles ok.

The velocities in the channel and the slots so the velocity in the channel like say if this is a channel. So, this is the velocity in the channel and velocity in the slot is this velocity which is the like the water is when water is moving in the slots. So, velocity in the channels and slots are given to us 1 point 8 and point 6 meters per second respectively the flow rate is 0.34 meter cube per second. Now we need to find the total head loss neglecting channel friction the power dissipated the mean velocity gradient the GT value at the detention time is 30 minute and the loading rate.

So weight loss when water flows through say some channel is generally V square by 2 g and in the slots also it will be V square by 2 g actually for each slot and each channel. We need to neglect friction although this is not an ideal case in actual cases there would be friction but if we neglect channel friction say we are not considering channel friction then the total head loss is going to be basically because of these head losses in the channels and head losses in the slots which is simply v square by 2g.

So, head loss in each channel the velocity in the channel is say one point 0.18 so 0.18 square divided by 2g which is equal to this and head loss in each slot in fact not channel. So, head loss in each slot the velocity is 0.6 so 0.6 square divided by 2g which is equal to this. Now total head loss if we neglect the friction losses is going to be 16 times of the head loss in the channels because there are 16 channels. So, 16 into head loss in the channel and there are 15 slots so 15 times head loss in the slot.

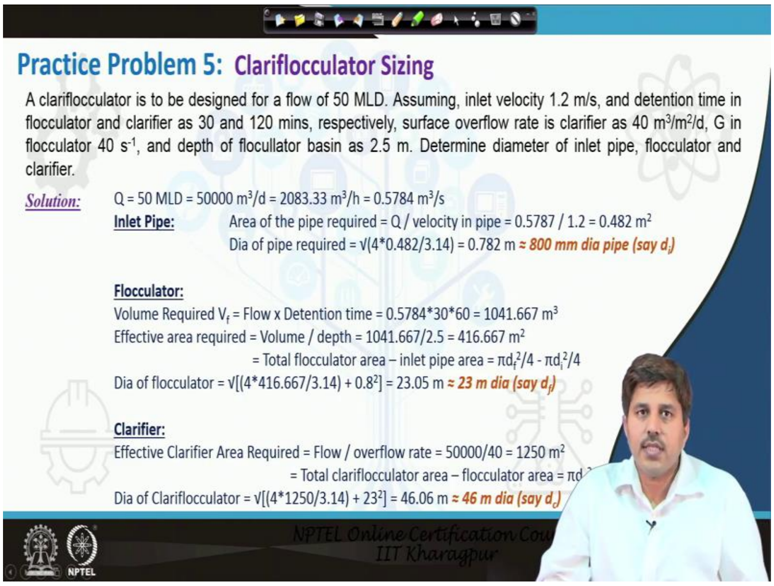
This is actually coming as point 3 meter, so that way we can estimate the head loss as point 3 meter. Now the power requirement is gamma Q which as we discussed earlier when we are trying to move water so the gamma standard gamma value for water this is the discharge and this is the H value head loss if you are taking friction losses as well. So, this H will be like will should include friction losses as well.

And then accordingly we will get the higher H value but for this particular case if you are neglecting frictional losses assuming a frictionless surface then it is going to be this value and if you multiply we get 1005.82 watts as the power required. Now we can estimate the mean velocity gradient we know that p is taken as like g into mu V g square mu v or mu v g square. So, g is square root of P by mu V, so that is what we will be doing P by mu V.

So the power we have already estimated mu value is given to us and the velocity which is 5 into not velocity sorry volume 5 into 4 into 60, so 5 into 4 into 60 this is coming as 27.24 per second. Now Gt value is the G into t and time is the 30 minutes, so since this is per second we need we will convert time also in the second so 30 minutes into 60 seconds is the residence and this is the G value per second so the total Gt value is 4 point 6 into 10 to the power 4 what we are getting from here.

The loading rate is Q by V so per unit volume how much flow is basically applied. So, flow is 0.34 meter cube per second or if you want in a meter cube per day we need to multiply it with a 3600 to convert it to hour and then 24 to convert it to day. So, this becomes meter cube per day and 5 into 4 into 60 is the volume. So, 24.48 meter cube per day per meter cube is the loading rate in the channel. So, that is how we can see this.

(Refer Slide Time: 16:16)



The next problem is on the clariflocculator sizing so that clariflocculator is to be designed for a flow of 50mld. Assuming inlet velocity as 1.2 meter per second detention time in flocculator and clarifier as 30 and 120 minutes respectively, surface overflow rate in the clarifier as 40 meter cube per meter square per day G value as 40 per second and depth of the flocculator basin is 2.5. We need to determine the diameter of the inlet pipe flocculator and clarifier.

So, in a clariflocculator if you see the plan of clariflocculator say this is our clariflocculator overall in the center we have inlet pipe and then we have flocculator and then clarifier. So, this area particularly belongs to the flocculator and you can say that the like say this particular area is for clarifier. So, clarifier area is essentially equal to the total clariflocculator area but effective area is less because in between you have the flocculator and the inlet pipe alright.

So that way now if you see this the daya the discharge is 50mld which is equal to say 50,000 meter cube per day or 0.5784 meter cube per second. So, for we need to determine the daya of inlet pipe, for inlet pipe we have been given the velocity in the pipe is 1.2 meter per second so discharge divided by velocity will give us the area, so we have this discharge and this is the velocity so the area of the inlet pipe is 0.482 meter square.

So the daya of pipe required we can estimate because area will be PI d square by 4 is the area so daya is going to be equal to 4 times area divided by PI and square root of this. So, that is what it is 4 times area divided by PI and square root of this so this is coming out to be 0.782 meter or say assumed 800mm daya pipe for the inlet. So, that is our daya for the inlet this daya that we get the inlet pipe.

Next is the flocculator, so volume required for flocculator is going to be the flow into detention time. The flow is given to us the detention time in the flocculator is 30 minutes. So, 30 minutes this is per second so 30 into 60 so this will be the detention time in the second and this is the flow rate in meter cube per second you multiply you get the total volume in meter cube. So, 1041.66 meter cube is the needed as the volume of the flocculator.

Now effective area will be the volume divided by depth and depth of the flocculator basin is 2.5 given to us. So, we divide the volume divided by depth we get the effective area which is 415.667 meter square. Now in order to determine the area; like the daya of the flocculator you see there is daya inlet pipe is there in the center. So, the effective diameter this is we need to determine but effective area what we have estimated is leaving the inlet part.

Because that is what is the flocculator area inlet part is not that. So, the effective area is the total flocculator area minus the inlet pipe area, the floc; if say daya of flocculator is df if the total daya of the flocculator is say df so then PI df square by four is the total flocculator area minus pi di di is the inlet daya size, pi d square by 4 is the inlet area. So, this is the total flocculator daya based on that we estimate the area and then we subtract the inlet area out of this area in order to get the effective area from the flocculator.

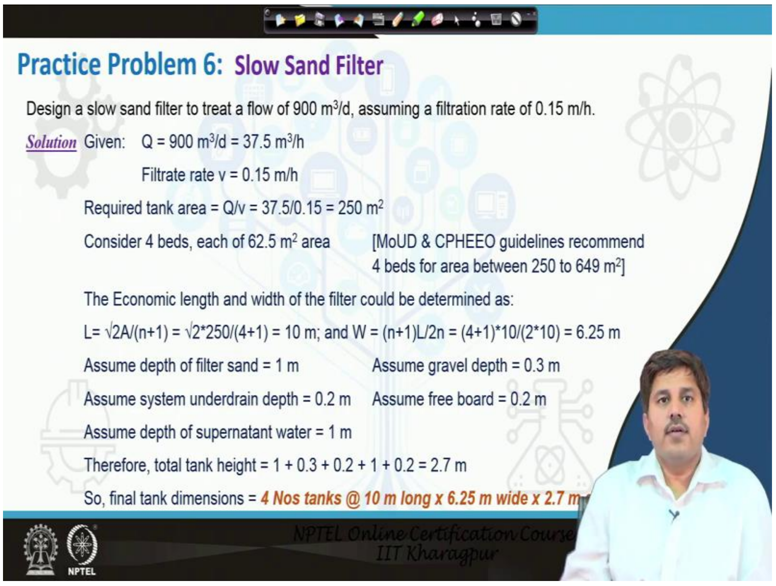
So from here we can this is the effective area of the flocculator required so if say the effective area of flocculator is say Af per se. So, then Af is equal to this or we can say that PI by 4 is the common and we have say df square - di square or we can say that 4 into the flocculator area divided by PI is going to be equal to df square - di square or we add di square here so say this like we can say that this plus di square is equal to df square.

So we take the square root of this and we get the area flocculated daya flocculator. So, similarly we can estimate the daya of flocculator 4 into the area which we have estimated here divided by pi plus the inlet daya square. So, this comes out to be 23 meter say 23 meter daya we got and then for clarifier so effective clarifier area required will be flow divided by overflow rate as we discussed in the last week as well. So, the flow is 50000 meter cube per day and the effective loading rate is 40 meter cube per meter square per day.

So flow also we have to take in the unit in which we are taking the over flow rate over flow rate is per day, so flow also will take in per day. So, this comes out to be 1250 meter square. Again similar to that say this is our inlet this is our total clariflocculator and here we have the flow operation so the area of flocculator which also incorporate in fact the inlet daya as well. So, the total clarifier area is going to be equal to this much only so we need to again the total Clariflocculator area minus flocculator area if we did subtract we get the effective clarifier area.

And similar to here again we can get the dye of the Clariflocculator or clarifier whatever you call that zone is 4 into 1250 divided by 3.14 into 23 square. Earlier we took 0.80 square because that inlet daya was 0.8 here the flocculator daya is 23, so we get 23 square and this gives us 46.06 or say 46 meter daya will be required for this purpose. So, that is how we can estimate.

(Refer Slide Time: 23:06)

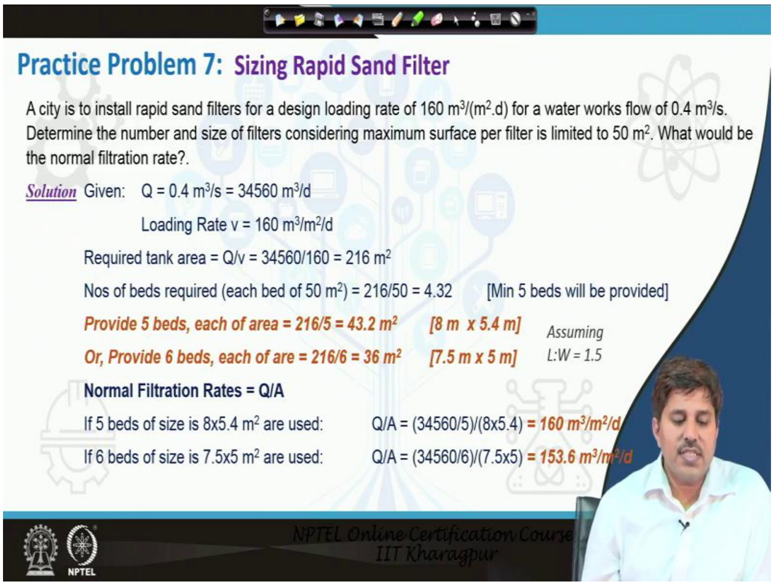


Now let us move to the some examples from the filtration. So, for slow sand filter let us say this is a problem simple problem designer slow sand filter to treat 900 meter cube per day flow assuming a filtration rate of 0.15 meter per hour. So, the flow is given a 900 meter cube per day the rate is given 0.15 meter per hour. So, the required tank area would be would be Q by V so Q divided by V what we get is 250 meter square. Now as per MOUD and CPHO guidelines for area ranging between 250 to 649, meter square we need to provide 4 beds minimum.

So, let us provide 4 beds we provide 4 beds and then economic length and width of these filter beds we can determine as discussed in the class so length is going will be can be estimated from this formula which is coming as 10 and width can be estimated from this equation which will be basically 6.25 so we get the length we get the width, we can make all other assumptions like the filters and 1 meter the under drainage system 0.2 meter the depth of the supernatant water one meter the gravel depth 0.3 meter.

The assumed like freeboard 0.2 meter all from the specification or manual. So, total tank height is going to be around 2.7 meters say so we can provide 4 number of tanks 10 meter long 6.25 meter wide and 2.7 meter deep. So, that is how basically we can put through a simple sand filter slow sand filter.

(Refer Slide Time: 24:47)



For rapid sand filter let us say a city is to install a rapid sand filter for design loading rate of 160 meter cube per meter square per day. So, this is our design loading rate of water works flow is for 0.4 meter cube per second we need to determine the size and number of the filters. Surface area per filter is limited to 50 meter square and we need to get the normal filtration rate as well. So, normal filtration rate in fact is this one only the loading rate at which the water is loaded to the filter.

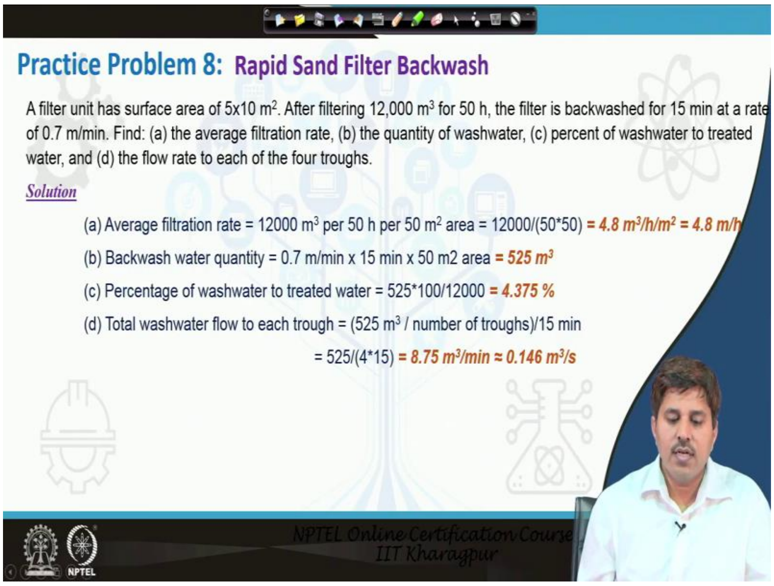
So, this is the information given to us require tank area again queue by the loading rate V so here we have Q as like 0.4 meter cube per second or 34560 meter cube per day divided by 160 meter cube per meter square per day. So, we get 216 meter cube as the effective area. Now number of beds required each bed of 50 meter tube 50 meter square maximum size so that way minimum beds required is 4.32 now we cannot provide the bed infraction so for if 4.32 is minimum requirement we need to provide minimum 5 beds.

So let us say we provide 5 beds each of area then 216 is the total area and if you are providing 5 beds so each bed should have area of 43.2 meter square alternatively like we can provide 6 bed also because it is more common to have bed in the even numbers. So, although this is also correct but we can provide say we can have other option it depends on the designer so we can have other option of providing 6 bed.

So in this d6 bed each will have an area of 216 by 6 that is 36 meter square. So, assuming length to width ratio 1.5 the dimension we can use for this is 8 meter into 5.4 meter and this 7.5 meter into 5 meter. These are little higher than 36 in fact it will come around 37 but that is like in order to put a dimension which is more implementable we can do a little adjustment. So, the normal filtration rate is Q by A if you are providing these 5 beds of 8 into 5.4 meter square size so the Q is this is the total discharge spread over 5 beds so divided by 5 into the area.

So, this is again comes the same number that we have because the area is exactly same 43.2 and if we are providing 6 beds of 7.5 into 5 meters again this divided by 6 and area so because area is little higher so we get instead of 160 will be getting 153.6 meter cube per meter square per day as the nominal filtration rate.

(Refer Slide Time: 27:34)

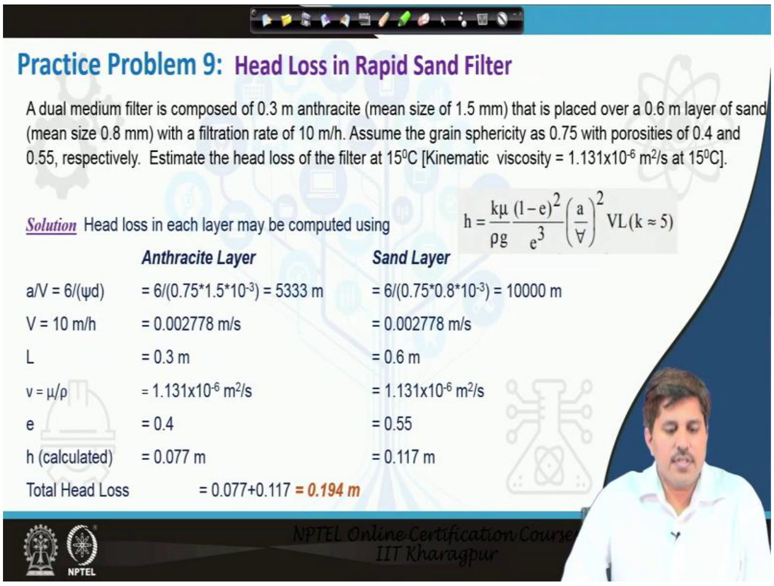


Our next problem is about the backwash filter unit has a surface area of say 5 into 10 meter square after filtering 12000 meter cube for 50 hour the filter is back washed for 15 minutes at a rate of 0.7 meter per minute. So, we need to find the average filtration rate now you see that 12,000 meter tube is being filtered in 50 hours per 50 meter square area. So, the average filtration rate will be 12,000 meter cube is being passed in 50 hours per 50 meter square area so this is becoming 4.8 meter cube per hour per meter square or 4.8 meter per hour.

Also we need to determine the quantity of the wash water so the wash water means the water which is being back washed that is actually being backwash is being done for 15 minutes at a rate of 0.7 meter per minute. So, 0.7 per minute is the rate 15 minutes is the time and 50 meter square is the area bed area. So, the total volume that is being liked provided is 525 meter cube in one cycle of the backwash.

The percentage of wash water to the treated water for every 12,000 lead, 12,000 meter cube treated it is requiring 525 meter backwash waters of 525 because we need to determine in a percentage, so 525 divided by 12000 into 100 so that is 4.375% water is consumed in the backwash. And wash water flow in each troughs so there are 4 troughs as given so this much water is the wash water this is divided into 4 troughs and it is being done in a 15 minutes period so this divided by 4 divided by 15 will be flow in meter cube per minute or 0.146 in meter cube per second so that way we can determine the;

(Refer Slide Time: 29:32)



So, the next question we have is on head loss in rapid sand filter. Now the problem statement is that we have a dual media filter which is composed of 0.3 meter anthracite layer. So, let us say this is our filter so we have a 0.3 meter layer of anthracite and 0.6 meter layer of sand the mean size for sand is 0.8 mm and mean size for anthracite is 0.15, 1.5 mm. The filtration rate is 10 meter per hour through both the layers the grains porosity is 0.75 the porosity of anthracite is 0.4 and of sand layer is 0.55.

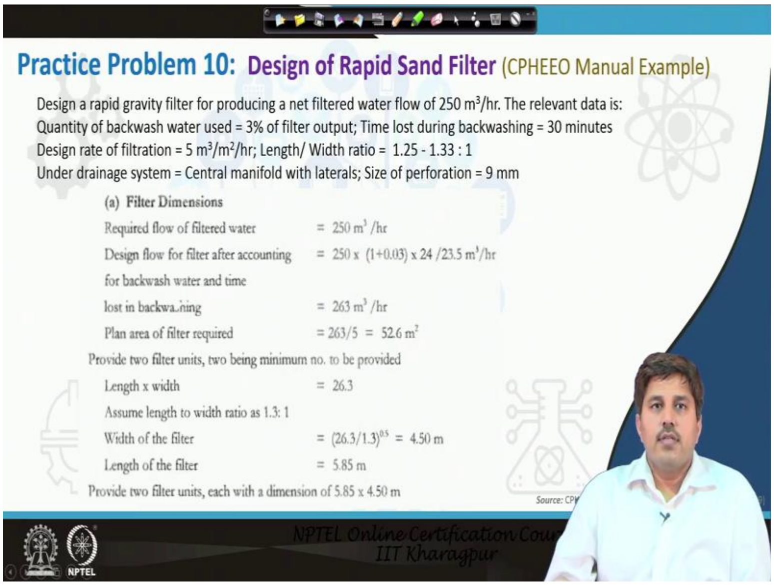
We need to estimate the head loss at 15 degree Celsius the kinematic viscosity is given to us. So, when we have 2 layer we can estimate the separate head loss through each layer and add it so or either we just add a by V values or we can do that way also here in this case since porosity values are also different we have porosity 0.4 here and 0.55 here. So, we can separately calculate. Now a by V which is basically 6 by Psi d d value here is 1.5 mm that means 1.5 into 10 to the power minus 3.

So a by V value we get 5333. And for sand layer similarly we can calculate again size the same the daya is 0.8 into 10 to the power -3, so we get 10000 meter as A by V value. The filtration rate is 10 meter per hour which is this in meter per second length here is 0.3 meter here is 0.6 meter the kinematic viscosity is given to us. So, we can use this value as a kinetic viscosity which is essentially the ratio of the dynamic viscosity to the density.

So this is what is we are having kinematic viscosity here all right. So, in this particular expression if you see k value is known to us the ratio of mu by rho is known to us g value is known to us the porosity is known to us in both the cases a by V is known to us the length of both the medium is known to us a and the rate of filtration is known to us. So, everything is known to us we can calculate using this formula the head loss for both the mediums. So, head loss for anthracite layer is coming 0.077 and for sand layer it is coming 0.117 meter.

So we can for getting the total head loss through the filter we can add these two because water is passing through both the layers it is passing through anthracite layer and then so head loss here is going to be 0.0077 and here it is going to be 0.117 so we add these two value and we get our total head loss as 0.194 meter so that way we can estimate the head loss through a filter.

(Refer Slide Time: 32:38)



This is the last problem which is a typical design example from CPHEO manual how do we design the rapid sand filters. So, of course we have not considered all the components like of the rapid sand filter design but since whatever was the purview of this course we have considered those element but there is a total detailed design example how these systems are designed actually in the field?

So say design a rapid gravity filter for producing a net filtered water 250 meter cube per hour that we need to produce the quantity of backwash water uses 3% of the filter output time loss during back washing is 30 minutes design rate of filtration is 5 meter cube per meter square per hour. The length to width ratio is 1.25 to 1.33 is to 1 and under linear system is central manifold with literals. Size of perforations are 9 mm. So, that is the information given to us.

First thing we can actually try to estimate the filter dimension now what we typically do in the design one important thing is if our output from the filter has to be say 250 meter cube per hour and we know that 3% water is lost in the back washing so filter need to produce these 3 3% extra water so that the net output can still be 250. So, the field because some water will be used in a back washing we need final output 250.

So the amount of filter outlet or Inlet should actually be compensating these 3% extra water also which is going in the back washing ok. So, the design flow should accommodate the back washing as well. So, instead of 250 will be designing it for 1.03 including that 3% this flow and then that is per hour. So, we can convert it to second thing that is that is what is going to be our design flow.

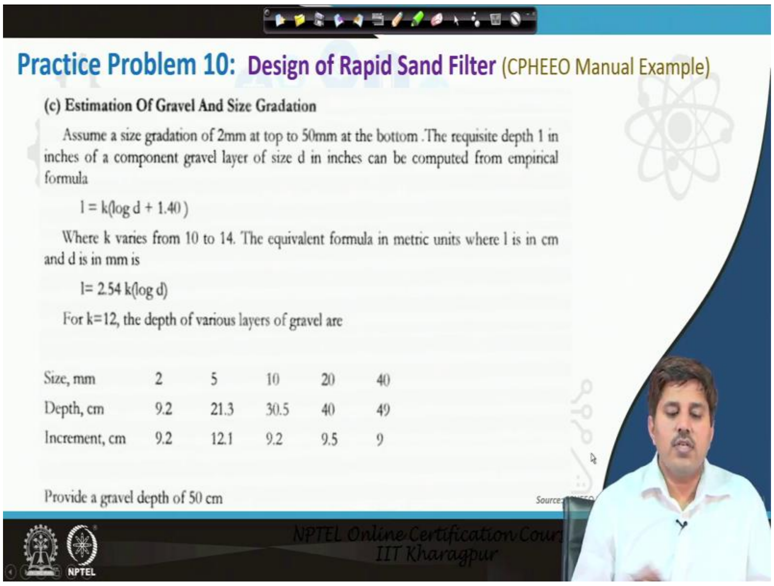
And second thing that filter has a backwash of 30 minutes in 24 hours so that means filter is just operating for 23.5 hours and not 24 hours full ok. So, in order to get the real rate it is not working for 24 hours. So, this is this is like whatever amount to 50 into 1.03 for accounting these extra water which needs for back washing purpose. This much water should be produced in 23.5 hours instead of 24 hours so the hourly flow rate that way we can estimate is 263 point 263 meter cube per hour is the hourly flow rate needed.

Now if 5 meter cube per meter meter square per hour is the rate of filtration, so we divide with the rate of filtration we get the area, say this is the area. Now we can provide minimum 2 filter unit so each unit will require this much of area and assuming a length to width ratio we can determine the width of the filter and length of the filter. So, that way we can estimate or put the length and width of the filter.

This is the estimation of sand, sand is generally like as we discussed during lectures sand is taken the sand depth is assumed that way but we can check that for breakthroughs that like whatever sand bed we are taking that is sufficient enough to be at that hydraulic load which is coming on to it and it is not basically going to this thing. So, for breakthrough purpose we can use this formula where Q is the flow and then basically H is the head and L is the length like this is the filter dimension and B is a factor we can which we can assume.

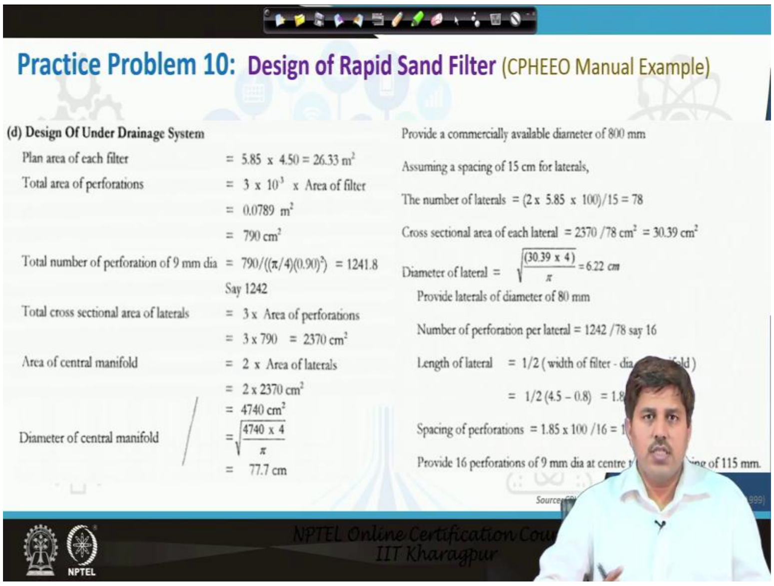
So, that way we can see that the minimum depth that would be required of sand would be required to avoid break through certain depth but it is not necessarily that the minimum depth which is estimated here would be used. We generally use higher we just check that the depth that we are using is higher than the break through depth.

(Refer Slide Time: 36:51)



This for estimation of gravel size again a procedure is mentioned in the manual so that procedure can be followed.

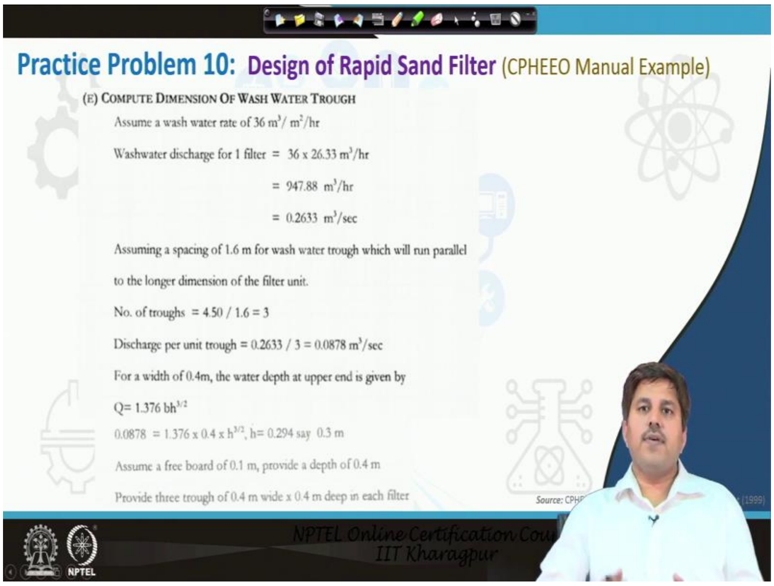
(Refer Slide Time: 37:02)



we are not going to go into much detail of these right now. This is the design of under drainage system again like there are certain clause that cross sectional area of the lateral has to be 3 times area of the perforations, perforations area alike as we said. So, the daya of the perforation we know so we can account for number of purforation and then the area of central manifold is typically taken 2 times area of the lateral.

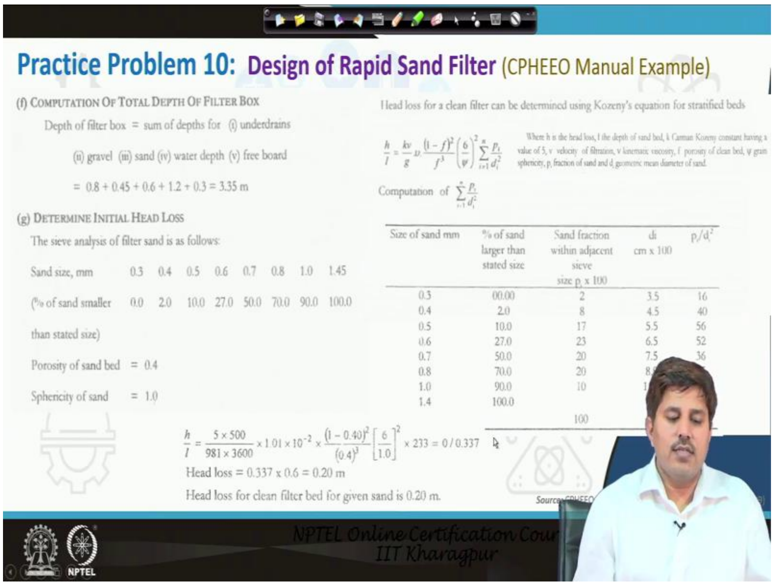
So that way we can estimate the daya of the central manifold, so all these and then assuming a spacing between the laterals assuming that.

(Refer Slide Time: 37:39)



So, all that way like there is a specified procedure to follow that which can be followed for designing. Similarly for wash water traps so we need to assume a wash water rate and then the discharge for each filter total number of troughs needed based on the maximum discharge so that also we can determine.

(Refer Slide Time: 37:58)



And this is basically when we know all the depth so the depths like total some of the depth would be the 4 under drain system gravel systems and system water depth system freeboard system and that way we can estimate the total depth. The head loss also can be like if you are putting a different lever of gravel and sands and those kind of things. So, as just we said for each layer we can compute the head like head loss individually or we can compute the fraction in each layer that way and then compute the head loss using the standard equation. So, that way the head loss in head loss also can be estimated.

So with this we conclude the discussion for this week, we says this week we focused discussion on the coagulation flocculation and filtration processes. Of course there are much more details to these systems if we want to go for the detailed design but that requires far more time to discussing. So, if interest anyone interested please post questions in the forum will be happy to like provide more details on whatever information is needed there.

So thank you for joining and we will be closing this week here. And next week we will be talking about few more treatment processes which are disinfection kind of essential process and then other advanced treatment options which are available for specific contaminant removals from water. So, see you in the next week, thank you for joining.