Wastewater Treatment and Recycling
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Lecture – 06
Wastewater Generation and Quantity Estimation

Hello everyone. So, we are now in the second week of this course Wastewater Treatment and Recycling. And, this particular week we will be focusing on Wastewater Generation and it is Quantity Estimation, as well as qualitative characterization. And, what is the typical quality of the wastewater we get from the different sources. So, that is kind of things that we are going to discuss during this entire week. However, we will start with the basic of Wastewater Generation and Quantity Estimation.

So, how wastewater is generated in what quantity is generated from the different sources is that, what we are going to discuss.

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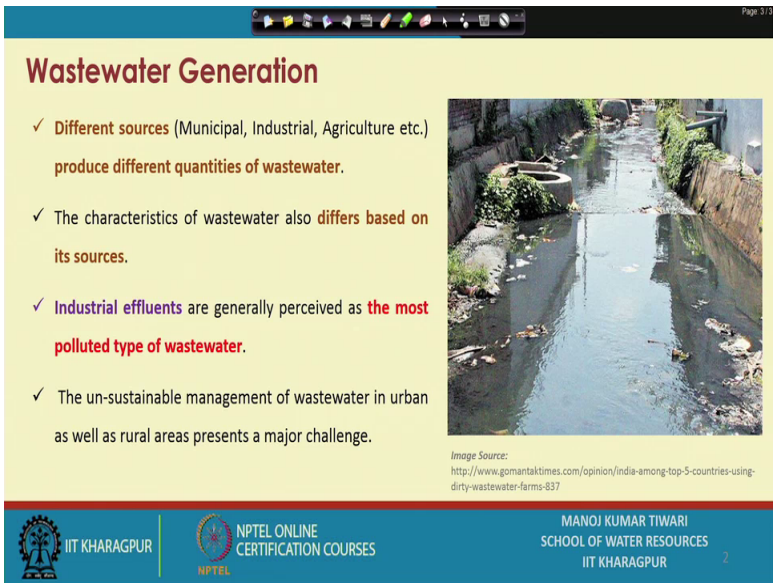

So, by now we know from our previous week discussion, that there are different sources for wastewater there are municipal sources, industrial sources, agricultural water can also be termed as a wastewater or those kind of thing. So, they there are different sources and these different sources produced different quantities of wastewater ok. The wastewater coming or originating from the domestic consumptions were, typically we referred as

sewage; the quantity of the sewage from a let us say city or a town would be very much different than the quantity of the industrial waste being generated ok.

So, particularly the quantity of sewage or municipal sewage is dependent on the population of that town, population of that city, whereas, industrial wastewater generated will depend on the what type and what size of industries are there and, which are consuming water.

So, the characteristic of this wastewater also differs based on it is sources, the characteristic of municipal sewage is different than that of characteristic of industrial effluent. Again industrial effluent does not have a fixed set of characteristic it depends on what kind of industries we are dealing with, it depends on whether it is a ternary, will have a different characteristic of wastewater which is being produced; if it is a distillery, it will have a different characteristic for pharmaceutical industry, the wastewater characteristics is different. So, that way the quality as well as quantity of wastewater will vary based on it is sources.

The industrial effluents are generally perceived as the most polluted type of wastewater, because the generally the contaminant load that comes with the industrial effluent or industrial wastewaters is many fold higher than that in the domestic sewage. Domestic sewage is generally either less or moderately polluted whereas, many of the industries not for all, but many of the industries are actually the very severely polluted in some cases the major parameters shooting up very high, then that of the permissible limits.

The, management of wastewater particularly in India in urban as well as rural areas are highly unsustainable. And, this is a major challenge that our countries facing. Because we will see some data, how much wastewater produces, and, how much get lost entry, how much get actually goes to our, natural resources untreated and how much we are able to treat, then recycling is even poor the percentage of water that is recycled is very little.

So, all those issues are there and overall if we see in fact, our government our all the institutions say related all the stakeholders related to these wastewater management sector, unanimously agree that at present what whatever the management practices are there for the wastewater are highly unsustainable and, there is a large degree of reforms are needed for better management or better handling of the wastewater.

Now, as we said in the beginning that we will be focusing on the qualitative as well as quantitative estimation of the wastewater during this week, and what we are going to start with first the quantitative estimation. So, how much quantity of wastewater is generated or will be generated from a city or from a town for which let us say we intend to manage the wastewater.

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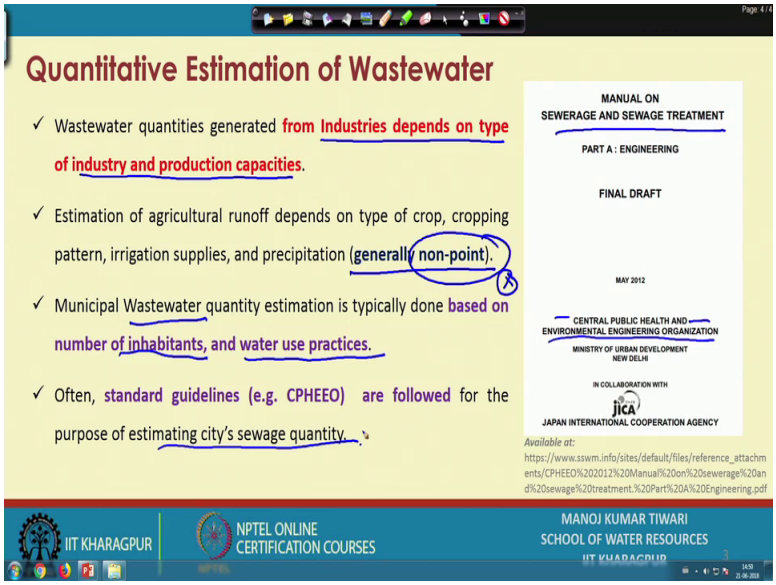

So, if we intend to manage wastewater, if you intend to manage the wastewater which is being generated out of a city, the first information that will be needed is how much is being generated. That is the first information that one needs and how much is being generated is actually, because it is not that just by knowing the size of the city or area of the city or the population of city, one can straight away tell that this much of wastewater will be generated. It is not that simple, it is not that easy, there are engineering practices and there are engineering protocols, which are to be followed for estimating the quantity of wastewater likely to generate from a city and we are going to discuss those approaches.

So, as we said that wastewater come from the different sources, so, wastewater quantity is generated from industries will depend on the type of industry and it is production capacity. So, it is very kind of very difficult to manage, that how much wastewater will be generated. Difficult to estimate right away how much wastewater will be generated from the industrial, sector until unless we have a clear cut information of what type of

industries, how many industries and what capacity of those industries are there in that area.

So, for say if there is a ternary so, there is per unit waste generated out of a ternaries depending on it is final product production. So, what size of ternary? If, it is a large size ternary; obviously, the amount of wastewater generated with be much larger, then that of a smaller size ternary ok. Further, water footprint of different industries or different, companies are different ok. There are certain water intensive industries, which generate huge amount of wastewater there are certain. Now, if you come for a production of let us say, leather or for the production of textile or for the production of medicines. So, for unit amount of production of medicine or textile or leather the amount of waste generated is going to be different.

So, it totally depends on what type of industry is there and, what is the production capacity of that, industries. Agricultural sector wastewater, which is agricultural runoff in a way, will depend on the type of crop what is the cropping pattern, what are the irrigation supplies, how much rainfall is taking place.

However, generally these sources as we discussed during week 1 also are nonpoint sources. And, it is very difficult to capture nonpoint sources and do any intervention for that. So, at a planning stage mostly agricultural effluent or agricultural runoff is not considered for town planning or urban planning. Anyway, more stop the agricultural activities are centered towards the rural areas and not towards the urban areas, but anyway; so, this the wastewater coming from the agricultural sector are largely ignored, because of it is variability, because of it is nonpoint source nature, because of the difficulty to attend although it may have at times very critical pollutant.

Ah. The agricultural sector water coming may have pesticides fertilizers and are known to basically pollute our natural water resources, but owing to the difficulty generally for the particularly for the planning of sewer, urban sewerage network or those treatment facilities this is ignored most of the time. So, now, we come to the most important fraction of the wastewater and for which our government bodies like municipalities, and these have the responsibility to collect, to treat to purify is the municipal wastewater or municipal sewage what we typically call or just sewage.

So, the quantity of sewage estimation is typically done based on number of inhabitants. What is the population of that town, how many people are residing there that is one more, that is one of the important factors, and then what are the water used practices. Water use practices as in the main point of bringing in water use practices is how much water is consumed by a person? So, if I am consuming let us say overall 100 litres of water a day so, I am likely to release the 100 litre of wastewater at in a day ok.

So, that way from all my activities from bathing from, a cooking from, cleaning all activities so, if that 100 litre water is being consumed by a person, the person is bearing some losses minor losses, it is all the water which is being used will is likely to release back ok. So, if the same water is being released back so that will give an idea of what is the total wastewater generated per person or per capita wastewater generated. And, then if we know that how many users or how what is the population size that is there in that town? So, if you multiply the average per person water wastewater or per person sewage generation into the number of persons we may get and estimate quantitative estimate of sewage generation.

Often, standard guidelines like we have CPHEEO manual ok which is Central for Public Health and Environmental Engineering Organization, this is one of the organizations which provide the guidelines for design of such facilities. So, if we follow their manual on sewage, sewerage and sewage treatment so, there they have given the adequate details, that can be adopted or that can be followed for the purpose of estimating the total sewage quantity coming out of a city so, that is how these estimates can be made.

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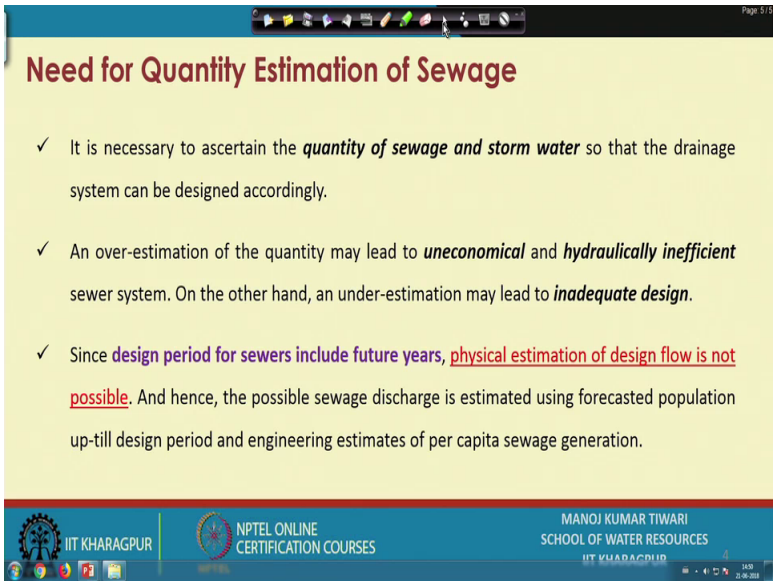

Now, if we ask what is actually the need of this quantity estimation of the sewage? Why we are talking about this ok? So, the first thing that it is necessary to sort of certify or sort of know that the quantity of sewage and storm water which is coming. So, that the drainage system of the city or drainage system of the town can be designed accordingly ok, we particularly in India, we face all these issues pretty often our sewerage systems are not properly designed. And, that results in the often our sewage does not passes to the adequate location. Even, if there is a treatment plant many times our sewerage does not reached to the treatment plant, because of it takes other routes to dissipate at times.

Then, there are many times there are there was a concept of earlier combined sewerage systems, when rain storm water or rain water excess rain water. So, storm water and sewerage are combinedly flow through one single network, and that has again because of improper design or because of improper conceptualization has created several issues. And, we often see particularly where there is a combined sewerage system, if there is inadequate capacity or those we often see that the overflowing of sewerage system, blocking choking all this things are pretty frequently seen in many of the cities and many of the towns.

So, if we overestimate the quantity of sewage; that means, we are going to design our system for a flow which is not there. So, that is going to make our system or our sewerage network hydraulically inefficient, because we have sort of designed for a flow

which already which is not existing, the flow is much lower. So, the head loss and all those thing that will come accordingly will change. And, the our sewer system may not be hydraulically efficient. In addition it is; obviously, going to be uneconomical as well, because if we design for a flow more than required so; that means, we are designing for a larger flow, our infrastructure will be accordingly of a bigger sizes our pump size needs to be higher, our pipe sizes will be larger, pipe dia will be larger.

So, eventually we are going to set a lot more amount, we are going to expand a lot more amount then actually needed and that makes our system uneconomical. On the other hand if we underestimate, then again our design is going to be inadequate. So, if let us say our actual generation is for say thousand MLD and we estimated to be of 600 MLD. So, our design will be based on the 600 million litres per day and when there is a thousand million litres per day flow. So; that means, our design is not adequate there will be overflows, there will be a problem, there will be pressure breakage situations all those things will come into the picture. And, in case of underestimation as well our system is going to get the funk pretty soon.

So, the over estimation or underestimation of the sewage quantity is going to create problems, while designing the sewer network. So, if we want our city to be to have a proper sewerage system, to a proper sewer network a good drainage system, then we must estimate the quantity of the sewage or the quantity of flow, which to be which need which will be carried out by the sewerage system to a fair degree of accuracy ok. We may not be totally accurate, it is very difficult to basically get an exact accurate flow because it is anyway estimate, but a fair degree of accuracy is must for estimating these.

Because, otherwise as we discussed in overestimation or an underestimation both going to lead a certain problems for the network. Now, since the design period for sewers include future years ok. It is not that if we are planning let us say sewerage system, today for a any city let us say Bhilai, Raipur, Jamshedpur any city you take, if you are planning a sewerage system for a city today; obviously, we are going to invest huge amount of money and we want that system to work for a certain years. It is not that we did this year and then we again we are going to do it again next year or a maybe couple of years later, it is not done that way. The typical this kind of investment the large infrastructure investments are done for a significant design period.

So, if we are going to let us say design it for 30 years. So, since our design period will have many more future year if you are designing today. And, we are today in let us say 2018 we are designing a system for 30 years; that means, we are designing a system which should be capable to last till 2048 or. So, if we are planning a system which can work till 2048 and we are going to make investments today.

So, we need to get an idea of what will be the flow that time in 2048, because if we design with today's flow it will serve the today's need. And, as an when the population increases down the line say 2 year 3 year 5 year, the flow will increase our system will not be able to accommodate that extra flow and it is going to be fail.

So, that is why the systems or the sewerage systems are designed for futuristic population. And, since there is a future years involved the physical estimation of the design flow is not possible. We cannot exactly or we cannot precisely estimate for any place, what is going to be the population in say 2040 or 2050? We can just make an rough idea, we can forecast a population to certain degree of accuracy, but there is no certainty that that number is going to be hold exactly true.

So, there is a lot of uncertainty involved and this, because we are talking about future years. So, the only way to get an idea is forecasting the population, forecasting the demand, forecasting the sewage generation, it is not possible to physically measure ok.

We cannot measure now, what will be the flow in 48? That flow has not occurred so; there is no chance of measuring it. So, that way it the possible sewage discharge is estimated using forecasted population up till the design period. And, then we have to apply our engineering principles to get the estimates of the per capita sewage generation in that period. So, once we get these 2 numbers, then the concept is pretty straight forward.

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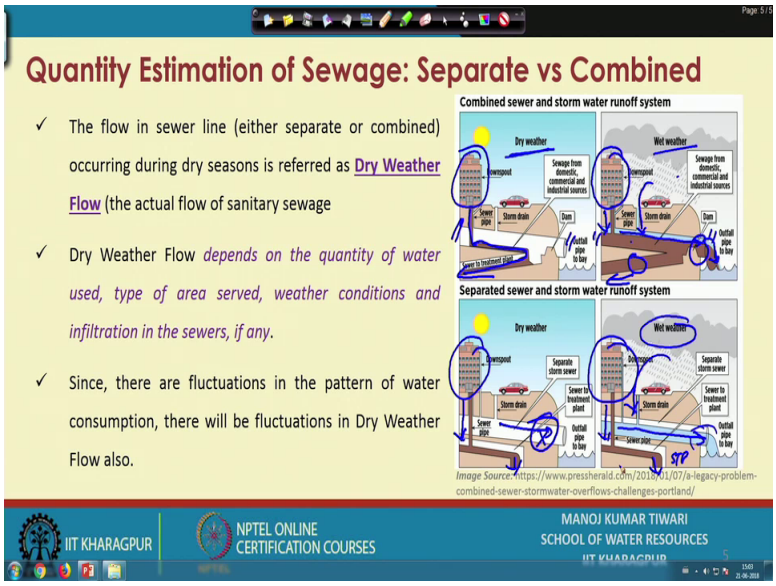

We can multiply them and get the estimate of the quantity of the sewage. Now, the sewerage system typically are of 2 types, the separate system separate sewer and a storm water runoff system and the combined sewer and storm water runoff system.

During the late years of the previous century, this the combined network became fairly popular as people thought that, it will it will not be voice to layout 2 different systems for one for sewer, one for runoff. However, it has created lot many problems later on and these days people have come across or I have been made aware of those problems. So, it is no more that attractive as it has to be in the earlier time. The idea of combined sewer and storm water runoff system is that, we have just one single system so, for say if you see here if you see here.

So, in the dry weather season when there is no rain, you have sewerage system in you have a system involved a combined sewerage system which is typically called a combined sewer system installed. So, out of the your domestic or commercial or out of the urban sewage is coming through the sewer pipe, which is coming to this channel and then going to the treatment plant. What happens? In the wet weather when there is a lot of rainfall?

So, the water consumed or the sewer is still coming in there. And, the rainfall coming through that storm drain so, that is also coming into the same sewer. So, we have the our channel which was running mostly into very little flow was there, because it had only the

sewage flow may run quite full because lot of storm water and storm drains are coming. So, a lot of rain water is coming precipitation water is coming.

So, now this is connected and part of based on our the capacity of treatment plant, what isoever is the capacity of treatment plant? That much water can be pushed, can be flowed, through the can be generalized to the treatment plant, while the remaining can be discharged directly, because there is no capacity for that. So, the idea is that the there is only one sewerage system this main sewerage system, if you see this is just one sewerage system which carries the sewage as well as the storm water runoff.

The separate system has 2 different 2 distinguish systems. So, in dry weather flow, you may have let us say this is your storm water runoff system; there would not be any flow in this because in dry weather flow there is no rains. So, there is no storm runoff generated. So, when there is no flow it will run totally dry, while there is a sewer network which will take the sewer to the treatment plant, treatment system. In wet weather flow, again your sewerage system will work as it is, it is going to take the sewer generated or the wastewater generated to the sewage treatment plant or STP, while the rain water or the storm water will basically be flowing through this is storm water channel which can directly be disposed of, because of the no pollution or very little pollution road in this.

So, that is how the tool systems are conceptualized? The separate sewer and storm water runoff system and combines sewer and storm water runoff system, each has it is own advantages and disadvantages this the combined system is less cost intensive, because we need not to lay 2 different drainage systems, while one of the major problem in the combined system that, when the particularly in the wet weather flow when there is a lot of runoff generated it get mixed.

And with the wastewater and that load or the quantity of the wastewater, quantity of the diluted wastewaters becomes too high. So, either you discharge lot of pollutants into your natural rivers or because your treatment capacity is very limited. And, what isoever you are even channelizing to the treatment capacity, because of the dilution the load has reduced.

So, your treatment system again may not work appropriately, because the pollution load has decreased. And, most of the wastewater treatment systems are of biological nature.

So, they need adequate amount of organic matter present in the present in the water, for producing good efficiencies. We will talk about that detail when we discuss the treatment, but this is how the 2 concept or 2 systems are there. Now, the flow in the sewer line either separate or combined, which occurs during the dry season, is referred as dry weather flow.

So, whether it is a combined sewer network or separate sewer network you see that the flow, because in the dry weather there is no storm water runoff. So, what isoever flow is generated is actually the actual flow of the sanitary sewage. Now, since this is a actual flow of the sanitary sewage this is what is referred as dry weather flow? Dry weather flow in terms of sewer network ok. So, this dry weather flow will eventually depend on what is the quantity of water used? What are the type of area served? What are the weather conditions and if there is any infiltration in the sewer ok.

So, this infiltration particularly, because you see that the sewers are generally buried in the ground so, they are generally subsurface sewer lines are there. And, if you have any storage water storage on the top there could be possibility of the leaking or infiltration taking place through that, if there are faulty joints in this kind of thing many times the groundwater table is higher than the sewer alignment. So, there is a possibility of infiltration from there as well. You know all these things are there, which can come during the dry weather season during the no rainfall season and that what is typically referred as the dry weather flow?

Now, since there is fluctuations in the pattern of water use, dry weather flow the measure of the most important component is the wastewater or sewage generated from the municipal areas, but since the water consumption pattern of these residential or commercial areas also fluctuates ok.

So, because in summer you will have higher degree of water consumption leading to higher degree of wastewater generation, in winters you will have lesser water consumption so, less waste generation. So, there are fluctuation there are yearly fluctuations, monthly fluctuations, daily fluctuations, we will have higher flow in the morning, lower flow in the afternoon, almost negligible flow in the nights. So, that way we can have the different type or different scale of fluctuations. And, since there is a

fluctuation in water consumption pattern, water use pattern, there will be fluctuations in the dry weather flow also which typically depends on this.

So, that way we can have an sort of idea of how the what are the various factors or what are the various inputs that are coming in dry weather flow? Of course, if there is storm water also coming in if in a combined sewerage. So, then hold dynamics of sewerage design changes, because the large flow out coming out of the runoff has to be integrated in there..

In case of separate system also a particular in the rainy season or if let us say there is a storm water channel going in here. So, there might be some fractures crack and this things in the sewer line. So, there is a possibility of some leakage coming in there. So, that can also contribute to some scale in the quantity of the sewage ok. So, this way the these are the sort of the important factors, that are needs to be seen, while estimating the quantity of the sewage. So, we will continue this discussion in the next lecture as well see you then.

Thank you.