Wastewater Treatment and Recycling
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Lecture – 23
Basic of Municipal Wastewater Treatment

Hello friends and welcome to week 5 for this course Wastewater Treatment and Recycling. So far we have been talking different attributes of wastewater generation, its characteristics, its quantification, it is natural attenuation. And, we started discussing some of the engineering aspects that; how the concept of mass balance and those kind of things can be used; or for designing a reactor or units which can engineerly treat wastewater.

So, this week we are moving towards the treatment of wastewater ok, the engineered treatment of wastewater. How the wastewater that we receive from municipalities or industrial effluents? How these waste waters are processed and the quality of the water is improved by removing the various pollutants or various contaminants present in the wastewater.

So, this lecture will be talking about the basics of; wastewater treatment, particularly municipal wastewater treatment. And then further we will start taking up one and taking up the unit wise; what are the various units for the wastewater treatment and we will have relatively elaborated discussions on each and specific units.

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So, to begin with the, what when we see that we are talking about the wastewater treatment, what is the basic objective of wastewater treatment ok? Why we are talking wastewater treatment? So, we have had earlier discussions on to this quickly you can see, that the basic objective of wastewater treatment is to convert a water of this quality to a water of this quality ok. Of course, just by seeing this we cannot say it is a good water quality, but apparently it is looking much cleaner as than this. So, it is supposed to have much lesser degree of pollution as opposed to this water.

So, wastewater treatment is processing or engineered processing of wastewater through a set of units, which removes the contaminants from it and in the in that context make the water quality better or improved.

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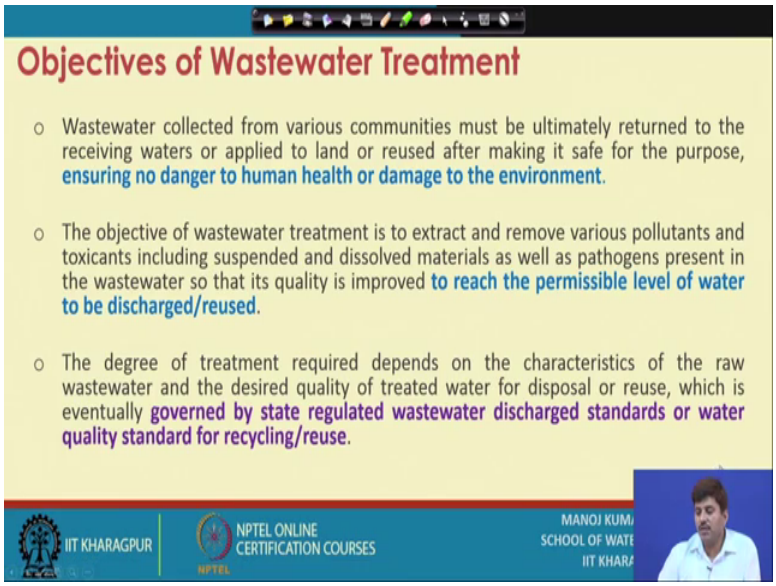

A specifically, if we talk about what are the basic objectives so, we know that wastewater is collected from various communities and should eventually be returned either to the natural systems. So, these are receiving bodies like; what rivers, lakes, canals, those kind of thing or is applied for land or is could be reused after making it safe for the purpose. Now, it could it should be either disposed off to the receiving waters or applied to land or reused only, when it is ensured that there is no danger to human health or damage to the environment.

So, this is one of the prime aspects and this is what triggers the concept of wastewater treatment ok. The objective of wastewater treatment is to extract and remove the various pollutants and other toxicants that include; suspended materials, dissolved materials, biological impurities which are present in the wastewater and when you remove these; what you get? You get the quality of wastewater, which is improved. And then the, to what extent or to what degree it should be improved that it should reach the permissible level of water to be discharged or reused.

So, we intend to either discharge that water dispose of that water or reuse that water to what so, that is going to be the ultimate goal, to which we should target the our treatment. So, the degree of treatment which is required will eventually depend on the characteristic of the raw wastewater ok. How the raw wastewater quality is, whether it is from municipal sources or it is from industrial sources so, and what are the influent

parameters, water quality parameters of the wastewater. So, all those thing will be governing to what degree of treatment is needed and then the desired quality of the treated water for disposal or reuse.

So, what is the desired quality? So, we earlier said that idea is to reach the permissible level and this permissible level actually is the desired quality. So, this desired quality is actually the permissible level minimum desired quality is the permissible level. So, we should we must treat that water to the permissible level. And thereafter we can even we can either dispose it off or reuse so, depending on whether we are talking about discharge we will need to look at the wastewater discharge standard, if you are talking about the reuse.

So, we need to bring the water to the water quality standards for recycling or reuse and these standards are mostly governed by the state. So, our government has some body assigned like in India we have center pollution control board. So, CPCB is the regulatory authority CPCB puts the guidelines or recommends their standards as per or ministry of environment and forests and climate change.

So, they in like corporate in collaboration work out and develop a set of standards, which needs to be followed; when we are talking about reuse, recycling or disposal of the waste water. These standards could be national for it could be different nation could have their own different standards or it could be international standards also at times.

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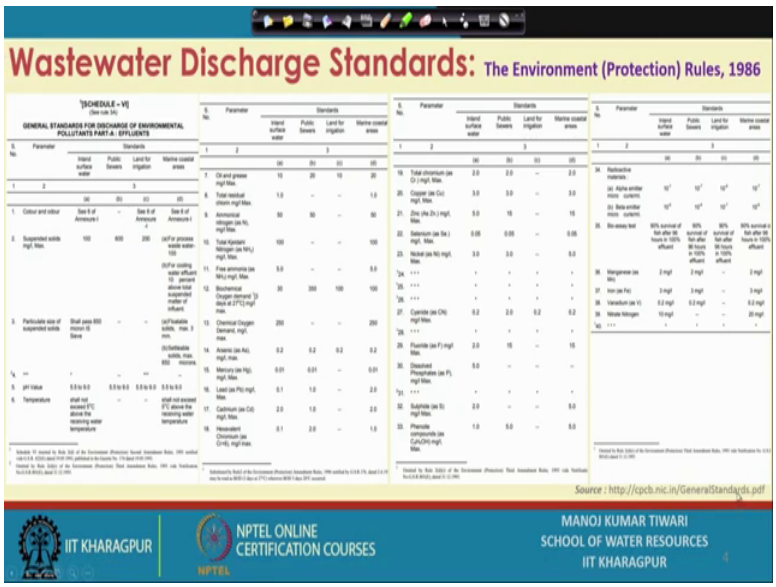

So, for say, the wastewater discharge standards in India, as per the environmental protection rule of 1986, we have there is a schedule available and which talks about the different Para range or recommended range of the different parameters. Which should be followed when, we intend to discharge the wastewater in our natural systems. So, depending on where we want to discharge for inland surface water we have a different set of standards for public sewers we have a different set of standards, if we want to use it like applied on land for irrigation or if we want to have a marine coastal areas.

So, all those in total around 39 parameters are listed here, including color and order suspended, solid, particle size, P H value, temperature, oil, grease, then nitrogen different form of nitrogen, ammonical nitrogen, total nitrogen, free ammonia, Biochemical Oxygen Demand BOD. So, you see the BOD foreign land surface water disposal limit used to be 30. It may not be readable, but then this is the source: which can be looked upon and all these details is available there.

So, you can always refer to the basic source and get this table ok. So, that way then there are different metals including arsenic, mercury, lead, the chromium, copper, zinc, selenium, so a variety of contaminant and pollutants are listed in this table. And, if we intend to put water for inland surface water disposal, we need to meet these standards if you want led to apply to land for irrigation, we need to meet these standards. So, that way, we have a set of standards available ok.

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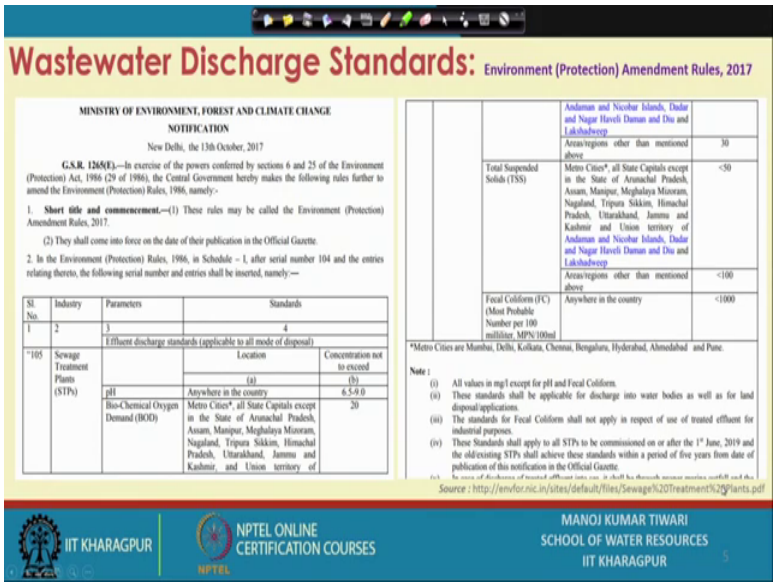

These standards are amended also at from time to time like: the latest amendment took place in the last year, when these environmental protection amendment rules were passed last year. So, here the basic change is the biochemical oxygen demand: which was in the range of 30 was reduced to 20 ok, the total suspended solid was bought to less than 50 milligram per liter ok, BOD limit is still 30 for areas other than the mentioned above.

So, there are all metro, cities, state, capitals, all those areas are mentioned so, for these areas the limit has been reduced to 20 and for excluding these areas the limit is still 30. So, that kind of like amendment or these things keeps on coming we can make stringent more stringent standards so, depending on how is the technological advancement to what extent we can achieve these values. Because standards should be achievable also, we cannot keep a standard which is very difficult to achieve or which requires enormous amount of say enormous amount of money or fund for treatment.

So, that probably would not people would which is very difficult to achieve or which requires enormous amount of say enormous amount of money or fund for treatment. So, that probably would not people would avoid achieving that. So, standards so standards are said keeping in mind the achieve ability of those standards ok.

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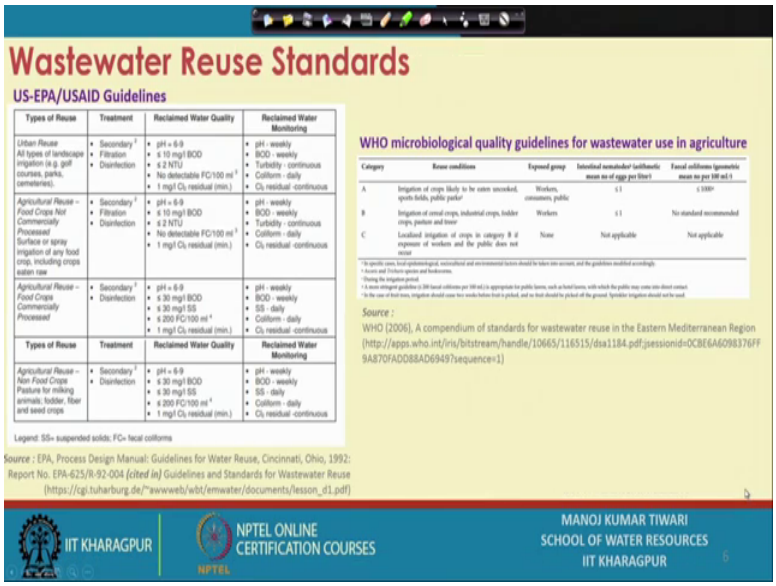

And that is why different nations or different agencies world agencies, state agencies, could have different standards as well. There are wastewater reuse standards as well, so like the US EPA or USAID guidelines, agricultural department and environmental

protection agency guidelines are there for urban reuse let say these are some of the set of parameters provided. Then for reclaimed water monitoring we have ok, then for agricultural reuse we have some set of parameters, agriculturally used for food, crops, we have certain set of parameters, agricultural used for nonfood crops we have certain set of parameters.

WHO also have also present its own guidelines for the waste water use in agriculture. So, these are the microbiological guideline so the pathogens and fecal coliforms, what should be their preferable range if we intend to reuse that.

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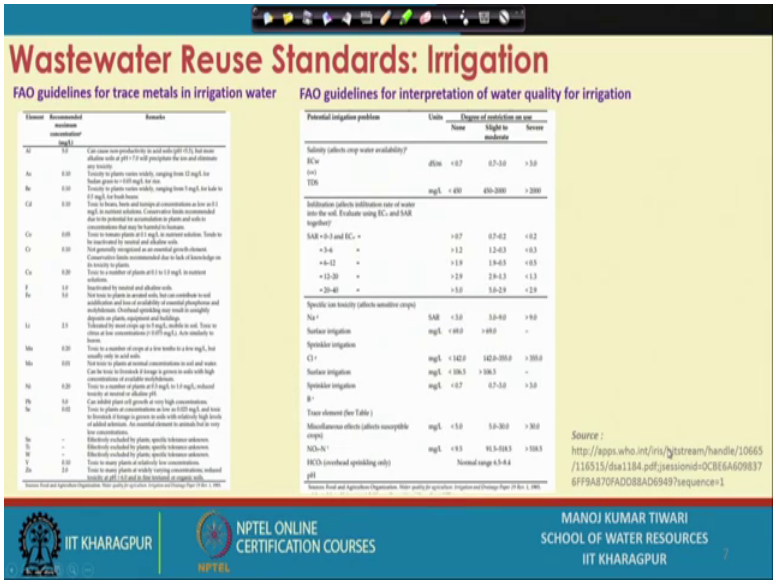

Food and agricultural organization of WHO also has presented some of this standard. So, for different elements ok, what is the recommended limit for irrigation reuse? Similarly for various other parameters sodium adsorption ratio, various metals and this kind of thing depending on the weather it is going for surface irrigation or sprinkler irrigation some of the parameters are suggested. So, that way the different the point like no one is expected or supposed to remember these values always. These are present in the public open public forum and whenever need, one can refer; that the idea of presenting it here is that this kind of standards are available ok.

So, people who are in this field must know that, where to look for such standards if you are let say planning a wastewater reuse. So, you should refer to the adequate standards,

the views standards may or may not be available for all the nations. So, like in India we have very limited standards for reuse purpose ok.

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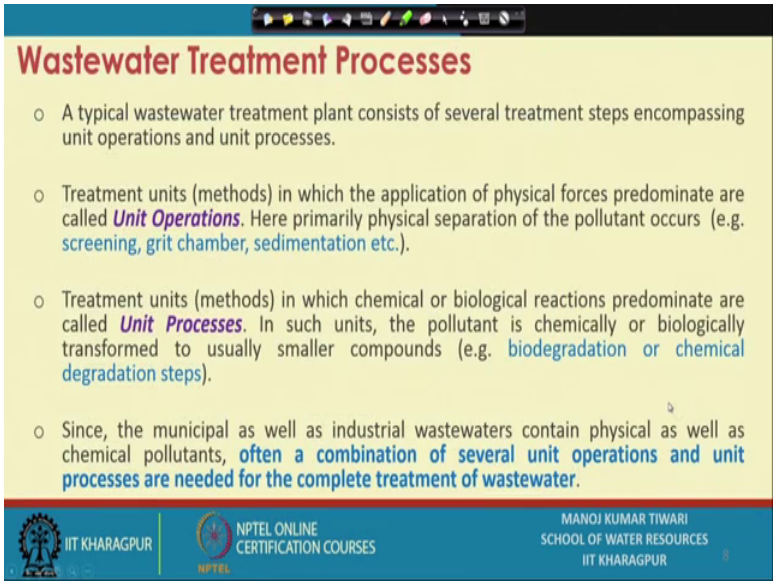

However we are encouraging more and more reuse options so slowly it is coming now. Then so, in order to meet these standards in order to bring the water quality from it is raw characteristic or the polluted water to the reusable or dischargeable water we must provide treatment. So, this treatment is typically, provide through various processes or various treatment units ok. So, if we say up if we talk about the wastewater treatment processes so a typical wastewater treatment plant will have several unit processes and unit operations ok. So, it actually encompasses various unit operations and unit processes.

The treatment methods in which; the application of physical forces are predominant are called unit operations. So, the processes which let say; works on predominantly physical forces so far say, the settlement of the course material say settlement of the sediments. So, that is settling by virtue of gravity because of its weight. So, there is no chemical reaction or biological reaction is involved. So, it is in this kind of processes are called operation unit operation ok.

So, unit operation are the basic physical processes and this primarily involves physical separation of the pollutant; that are there in through the screening, grid chamber or sedimentation ok. We will talk about in the detail what our screening, grit chamber and

sedimentation processes. Then we have the, unit processes ok which the unit operations are the one which works on physical principle similarly, the unit processes are the one which have chemical or biological reactions predominate the process. So, the pollutant is chemically or biologically transformed or degraded generally to smaller compounds ok, which is your examples would be the bio degradation or chemical degradation steps ok; like we did talk about the BOD reduction and all that. So, that is a biochemical reaction that is taking place.

So, those kind of units or those kind of methods are called unit processes. So, that is the basic difference between unit operation and unit processes. Now, since the municipal as well as industrial wastewater contain various physical as well as chemical pollutant and many of them are treated or removed through physical means while for particularly the organic wastes and those kind of combined compounds we need biochemical reactions ok; to decompose or degrade them.

So, the typical treatment plant often combines a several unit operation and unit processes and that will be needed for the complete treatment of wastewater. If you are just doing with a few select units you may not deal with all type of contaminants present ok, because something which is dissolved in the water let say dissolved organic matter; will not settle out you keep it for howsoever long.

So, if you try to remove that with sedimentation or screening or those kind of things it is not going to work. So, you we need dedicated processes for that and for a good treatment or for a complete treatment of wastewater a combination of various unit operations and unit processes are typically required.

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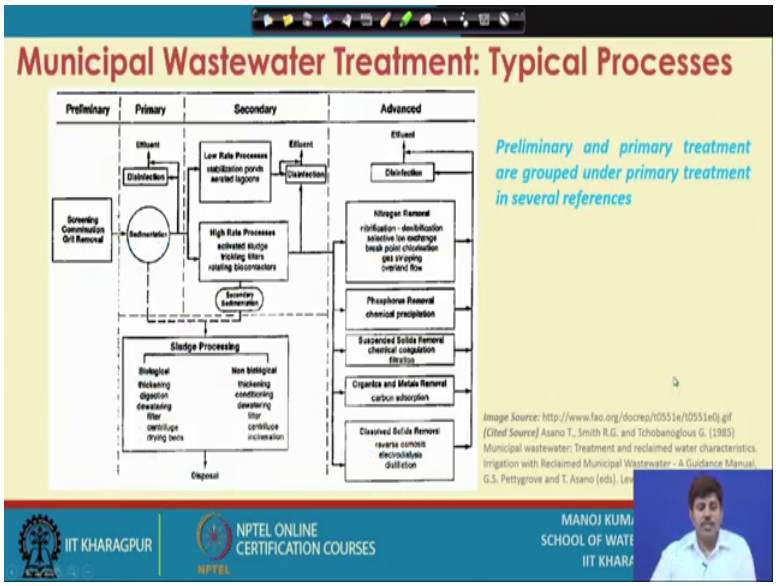

So, if we see the municipal wastewater treatment the there are; variety of processes and there are these are generally classified into various steps ok. So, there would be a preliminary treatment, primary treatment, secondary treatment tertiary treatment, those kind of steps are there. So, preliminary we have screening combination grit removal kind of processes are the preliminary treatment; primary treatment is primarily the sedimentation or the primary sedimentation which is also known as primary settling or primary clarification. Then secondary treatments are mostly biological treatment processes ok, where the waste organic waste is decomposed off or BOD and COD is reduced.

So, these are primarily the biological systems could be aerobic could be anaerobic, could be low rate process, high rate process. So, there are variety of options available, but; those will eventually fall in this and then the separation of the; bio solids produced from the water is also a part of secondary treatment which is called secondary settling ok. And then we have tertiary treatment; which is also referred as advanced treatment. So, here depending on the need we can select we can go for the advanced processes, which could include variety of processes including advanced oxidation processes, membrane processes, nutrient removal processes, disinfection, this chemical settling or neutralization kind of processes. So, depending on whatsoever left post secondary treatment and if you want to treat that so how we go; that will be based on the advanced or the tertiary treatment processes.

So, and this preliminary and primary treatment, so many differences or many books if you see; they club the these together and just refer this as a primary treatment. So, in a few places you will see that 4 categories preliminary, primary, secondary and tertiary or advanced and in some places you will see just 3 categories primary, secondary and tertiary. So, in those cases this preliminary and primary both are clubbed and are typically referred as primary treatment. Now what these different steps do ok, what are these different stages?

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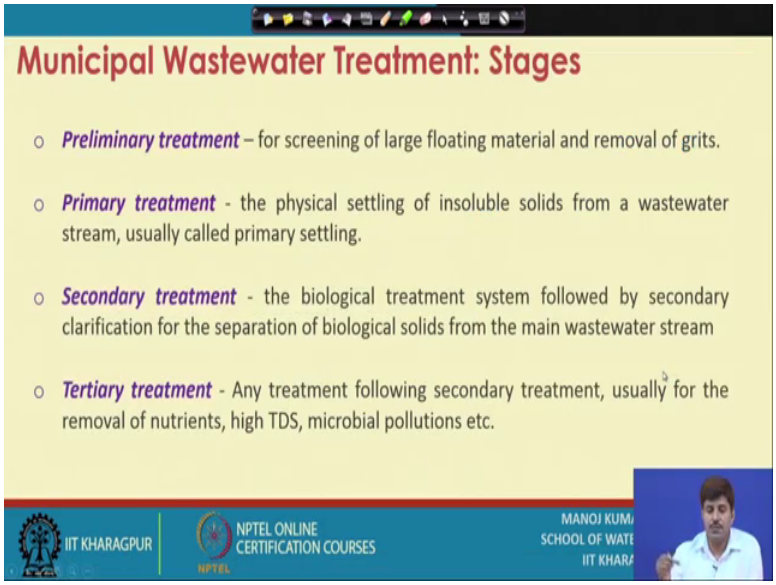

So, preliminary treatment is for screening of large floating materials and removal of grits that is the objective of preliminary treatment ok. Which is done through screening and grit removal, then we have primary treatment which is the physical settling of insoluble solids ok, which are there in the wastewater, that is typically referred as primary settling, then we have secondary treatment ok, which is the biological treatment followed by the secondary clarification for the separation of these biological solids from the main wastewater stream.

So, the basic biological treatment we will try to remove the; organic matter present, dissolved organic matter present and in the process the bio solids which are produced are separated by secondary clarification. So, these are the; secondary treatment processes and then we have tertiary treatment which is also advanced treatment.

So, tertiary treatment or advanced treatment are actually; the treatment that is followed after secondary treatment and it is usually for the removal of whether nutrients or high total dissolved solids, microbial pollutants. So, whatsoever are left after secondary treatment is actually removed or treated through this tertiary treatment process. So, these are the basic objectives of the various treatment stages; and then as we said; that many places these two are clubbed ok.

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Then, we have the like that way with a combination of these different units we can set up entire treatment plant, we can set up a complete treatment plant. So, what you see on this screen is basically, a couple of treatment plants; the aerial view of these treatment plants. So, this one is from the Nagpur ok, this is a Nagpur wastewater treatment plant and this is one of the treatment plants in the state of Indiana in the U S which is south bend wastewater treatment plant so, this is the how these treatment units or assembly of treatment units looks from the top.

So, will see that here, there are various units; there are some smaller units over here then there are these units for clarification this thing and then there are these units these a series of units are there. Similarly here you will see that; various types of units are aligned at various places ok. So, this way a combination of units will give the entire orbit we will sort of make the entire treatment plant for the treatment of wastewater. So, we

learned this; lecture here and in the next class we will start taking these different treatment units one by one.

Thank you.