Wastewater Treatment and Recycling
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture – 48
Wastewater Treatment System: Option and Conventional Approach

Hello everyone and welcome to the 10th week for this course Wastewater Treatment and Recycling. So, we have covered three-fourth of this journey. And this last 9 weeks almost couple of months; we have talked about various aspects related to the wastewater generation, its quantification, its quality characterisation, then the natural at attenuation and how it is dealt when it is disposed of in the nature and then the various treatment aspects.

So, we did talk about, the preliminary treatment, then primary system secondary treatment systems, the biological approaches and then what are the various advanced treatment systems which we discussed in the last week.

Before that we talked about sludge management as well. So, how this, sludge which is generated? How that is handled? So, that is what we have discussed. Now when we are discussing the treatment aspects we did talked about the various options various alternatives that are available for the treating waste water ok. Like once we say the go for a secondary treatment stage; so whether we want to use aerobic processes, anaerobic processes. Or if let us say we want to use aerobic processes so do we go for say some trickling filter kind of thing, do we go for conventional activated sludge processes kind of thing. So, there are lot of kind of options are available and has to make a call one has to decide that what treatment philosophy what treatment strategy I am going to follow on.

So, the discussions that we had so far was actually you need a specific, say if we begin from the let us say start from the beginning so the waste water as it comes it is 1st under goes kind of screening system, so, if you are providing a screen is a independent unit its roll is to capture the floating materials. Large floating material those kind of thing then it goes to say grit chamber, if you need it go to a colligation tank then say primary sedimentations; so each like operation of a primary sedimentations; how the water comes? How settling takes place? What it does? How it removes the suspended material?

So, that is just one specific unit and then which kind of treats or targets the removal of one particular type or one particular kind of contaminant.

So, for say your activated sludge processes are not supposed to remove or typical say your aviation system and is not supposed to remove, the suspended materials present in the waste water. It is suppose to remove the soluble COD. Similarly, your primary sedimentation is not supposed to remove much of dissolved organic materials ok.

In the processes it may remove something, but its primarily designed and intended to remove the suspended material. Your secondary sedimentation is intended to remove the biomass which has been generated in the earlier activated sludge unit and settle that out.

So, that way the different units has their different roles, once we go to the advance treatment also, say disinfection is suppose to kill the microorganisms; disinfection it not supposed to remove any sediments or remove the other kind of thing ok. So, that way your sludge handling units have their own separate role.

So, we have different units, whether it could be unit operation or unit process; they have their different rolls and we when we go for a treatment of waste water as a whole. So, if you are receiving sewage from a city, just one single unit cannot serve the purpose. So, we have to prepare an assembly of different units. This different unit processes and unit operations. Now this assembly that we generate for this different unit processes and unit operation will again have to arrange them in a proper sequence. So, that these as we were just saying the different units target different kind of contaminants or target different type of pollutants for the removal so which type of pollutant we want to remove first then we want to a kind of go to the next stage. That way we have to pick specific unit, we have to pick a specific arrangement of this units from starting to the end point and then only we can get a complete or the desired level of treatment of the waste water.

So, what we call the waste water treatment systems or waste water treatment plant is not just a specific unit, which we have discussed so far; the specific units of course, we discuss the plant configuration and how this units are arranged we did talk about related on to that, but when we talk about waste water treatment system, we intend to basically present or represent a set of various unit processes and unit operation from the beginning to the end, for the processing of waste water for the removal of all sort of unwanted pollutant or unwanted stuff which is there in the waste water.

So, this particular week, we are going to basically discuss about some of such systems. And as we said that we have different units we have basically so far talked about most of conventional treatment systems and of course few advanced treatment unit which we discussed last week. But, there although the processes more or less may remain same the physical chemical or biological process, but the arrangement of these units could be different and sort of overall packaging of a treatment system or a treatment plant could be different.

So, we are going to discuss some of those arrangements some those packaging's in this week ok, and how these different treatment systems which may actually work on the similar processes, on which the conventional systems works or the various conventional various units in a typical conventional works. So, how they are kind of could be rearranged or could be kind of module so that in order to get a effective treatment at the desired cost or desired level of energy consumption those kind of thing.

So, that is what, what is our target for this week, where we going to discuss the different type of a waste water systems: the conventional as well which will be briefly talking, but more so the various other alternative waste water treatment systems which are available these days or the waste water treatment practices which are being adopted these days. So, like we have variety of reactor configuration in the form of say MBBR, MBR, SBR those kind of things. So, that is what we are going to discuss in this week.

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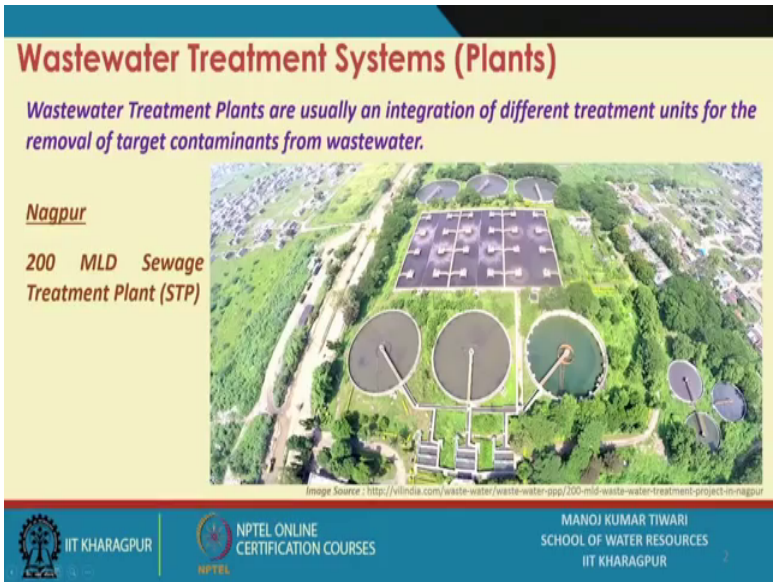

So, we will begin with the, very first thing that as we were discussing the waste water treatment system or waste water treatment plant. So, when we say, that when we basically talk about a waste water treatment plant, we essentially are saying that they are could be there is a possibility of variety of unit, there are various units over here, you can see that, there is one unit somewhere here one unit here one unit here that way.

So, they may be the like doing same processes or the might be doing different processes like the there are units here for something, these are some other units, these are some other type of units. So, they might be basically targeting for different processes this is actually an aerial view of the 200 million litters per day sewage treatment plant at Nagpur ok.

So, the waste water treatment plant when we say is usually an integration of these different treatment units ok. So, we have been talking about these different treatment units across last few weeks. So, its integration of these different treatment units for the removal of various target contaminants from the waste water. That is what waste water treatment plant or waste water treatment system is as a whole.

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So, if we see there are several unit operations and unit processes options are available for the waste water treatment systems. A treatment system can actually be purely physicochemical also or can be a combination of physicochemical and biological systems. As we were just saying one can actually adopt a aerobic system and anaerobic

system say advance oxidation processes, that they do not they do not go even for biological system.

So, there are variety of treatment options available and these are options do consist several unit operations ok, unit operations particularly and the one which works on mostly physic-chemical based principles, while there are unit processes which works on the biochemical based principles. So, there are variety of option under about these categories unit processes and unit operations and we have to kind of pick and choose to which unit we want to imply or which we want to integrate with our treatment system or treatment plant in order to achieve the desired removal ok.

So, it could be pretty simple, it could be tends pretty kind of complicated, that depends on variety of factors; like you see here one treatment plant which is in the blue plains, wastewater treatment plant in the Washington US ok.

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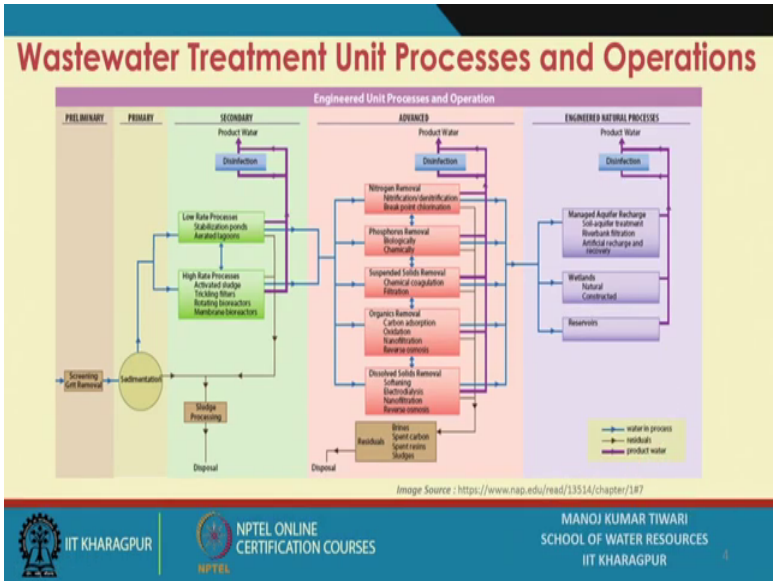

So, that way we can have kind of this thing. So, if we see the waste water treatment unit process and unit operations so there are variety of options available: there are preliminary treatment, primary treatment, secondary treatment. Then under advanced treatment then variety of options available over here and then kind of other engineer natural processes or those kind of processes are available ok.

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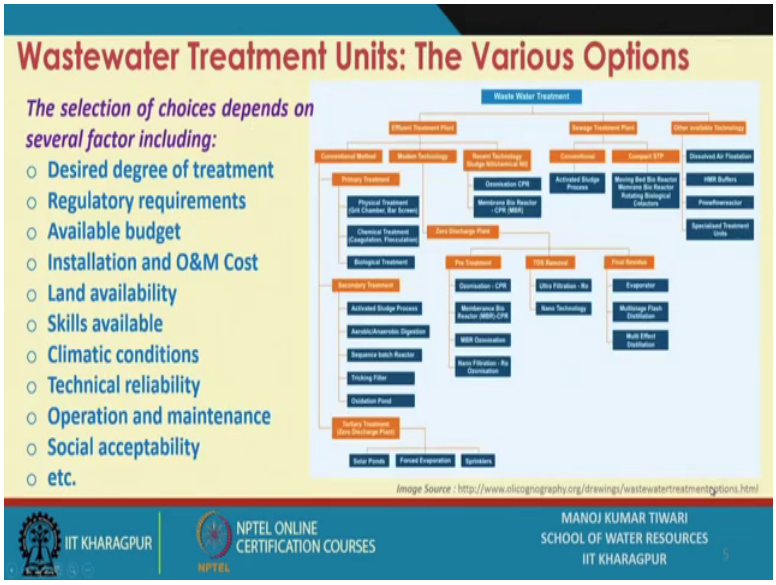

So, that way we have this variety of options, if we see there are options in much more detail. So, the waste water treatment, as we say that the waste water treatment we use for sewage treatment as well, or for industrial affluent treatment. So, for sewage treatment plants if we see there are conventional treatment options which is based on activated sludge processes or there are compact STP's in the various forms ok.

There are other options available for either of these for the effluent treatment plant; we have various conventional methods in the form of primary treatment, secondary treatment, and tertiary treatment. We have various modern technology where zero discharge plant or zero liquid discharge what we call. So, they for the pre treatment for the TDS removal for the final residues, management those kind of thing we have variety of options available. Then there are various recent technologies ok. So, like ozonization or your membrane bioreactors those kind of technologies can also be used, ok.

So, we have discussed majority of these in the last few weeks. Like in primary we see grit chamber bar screen and then coagulation flocculation or biological treatment, then secondary treatment activated sludge process or aerobic anaerobic digestion sequence you will (Refer Time: 12:34) which will discussing this week or trickling filter those kind of thing ok.

For conventional system also as we discuss the typical activated sludge process or we discussed anaerobic treatment setups as well. Since there are variety of options available so we have to make a choice depending on which eventually depends on several factors,

the choice as we make. It such that it is not that there is just for one particular type of contaminant removal, we have just one particular method. Same method, same type of contaminant could be removed by several different approaches.

So, like just last week, we when we are discussing the advanced treatment aspects; so we say that or your organic materials can be reduced by the advanced oxidation processes ok. So, you have an option to say go for full advance oxidation processes, you have an option for go for partial advanced oxidation process and then put it for the biological degradation or conventional biological degradation. Or there are unit such as RO and those kind of those kind of things which also can be used for removal of these constituents scale, to verifying scale ok.

There are other oxidants which can be used like chlorine or that kind of like ozone; ozone is there ozonation which is in fact, considered as a advance oxidation process step as well, for generation of hydroxide reticules. So, those kinds of systems are available. Now even again going in the advance oxidation process also there are various process. We need to generate hydroxyl radicals OH radicals, but which method we use to generate that. So, that will again it will change the probably or cost requirements, energy requirements, technical complicacy, the land requirements. So, some may have higher cost, lower land footprints some may have lower cost, but high land requirement, some may need great degree of technical expertises technical skills, some is easy to operate and maintain. So, that way there are like variety of options available.

So, when we have to say make a call or when we have to decide that for which treatment facility we want to go or for what kind of treatment facility we want to go, we have to see various things and these factors eventually govern our decision.

So, what could be these factors? Is the desired degree of treatment, so how much treatment we want to provide there is regulatory requirement. Your desired degree of treatment itself can depend on the regulatory requirements. So, if you are let us say going for a dispose so there is a regulatory requirement that this is the effluent discharge standards.

So, if you want to discharge that in a say water body you have to meet these standards and getting to those standards you have to have certain treatment approach. Then there are kind of even if somebody is let us say planning for reuse, so there is a reuse standards

regulatory, standards could also be there. So, that way we may have regulatory requirement which kind of governs our to what level we must treat the water or the waste water that way. Then the available budget ok, how much funds are available that will; if you do not have let us say ample amount of budget or enormous amount of budget and you plan a very high end process, which can give you say the best possible degree of treatment you plan to go for RO, but you do not have a budget for that, so how you go into install it.

So, the selection of process also depends on the availability of funds; how much funds is available, how much budget is allocated for that particular project.

So, that will be another criteria then installation and operation and maintenance cost ok. So, again depending on your budget once you know that these are the funds available. So, how much you can spend in terms of installation and operation and maintenance cost; that also will govern. Many times like process selection is done first and then the budget is asked from the government. So, again those kind of thing has to be seen.

Then the availability of land if you are planning, say a process which has a very high land requirement as we discussed during the sludge processing as well or there are various other treatment aspects which like forgot lands and those kind of systems we need very large area ok. So, that much large reason or that much area of land, whether it is available or not at the first (Refer Time: 17:42). Because if you are planning a waste water treatment facility at say urban area, densely populated urban area. So, how much land you can spare for those kinds of facilities that is also a question ok.

So, many times like the design or the process selection is primarily governed by the availability of land. And mores over in the industry and let us say you are planning an industry. So, you have all those resizing and these things now you have to treat industrial effluent, you cannot allocate in finite amount of land. So, you have a fixed reason available.

So, whatever process you go, whatever process you select it has to be compact enough to fit in that reason, in that area which is available ok. So, that is another criteria for kind of selecting these specific unit or that way govern deciding like full stages of the treatment. Then there are skills available.

So, if you say want to put a treatment system in a rural area or in developing world where there is not that great degree of skill is available. So, you can basically let us say install a plant, which requires significant amount of operation and control and you do not have available man power for that. So, those kinds of system the installation is fine some you will have somebody you can install it alright, but at operations stage there is a high chance of failure. So, for let us installing a setup in a rural area or in a village area; it helps to be operated by somebody. So, you need those kinds of skilled people who can stay in there and operate. So, if you find it difficult to manage those kind of skilled man power available. So, how you are going to basically manage even if this facilities installed.

So, that way that is also a criteria that how much skills is available in that particular domain. Then a climatic conditions is another factor. So, many times what happens that say you have a system which is working fairly good at an (Refer Time: 20:09) humid region or hot climate conditions, but you want to put through a system in a say colder climate. So, many of these micro biological systems, have these restrictions or limitations one can say that they would not be able to work that efficiently at a colder climate ok.

Because at cold climate the activity of the bacteria or the growth rate of the bacteria which is temperature dependent will itself go down, and as a result your efficiency may go down. So, depending on the climate conditions if you are planning for a let us say colder region, then you probably have to think of more of on to the physicochemical processes which can operate at even cold temperatures as well ok.

Where biological systems will have restrictions in working particularly if there are placed in the open. So, if you are planning biological system you have to think about the temperature controller adequacy of the biological systems, to work at the temperatures that are available there ok.

Then of course, there are operations and maintenance ok. How operation and maintenance is going to be done of that. And to some degree there is a social expectability which also can govern these things. So, for say for removal of certain contaminants, people go for treatment like bone charge is a very good absorbing for removal certain contaminants ok. But if you want to use put that water for reuse and

people in certain societies, let us say in India only they know that this is treated by the bones the bones of certain animals those kind of thing. So, many people will have objections on to reuse or to utilising that water further.

So, there is kind of social criteria may also come in picture which is not always relevant though ok, because many times particularly in the developed world this is not a big point of botheration; particularly for the waste water treatment until unless your go in to put it through reuse. For reuse purpose it is or reuse the social exceptability is one very big issue ok. Even in the most the developed world's if you want to reuse the water for say portable or domestic applications there is a lot of social obligations and social objections, that come through. So, that we are probably will be discussing at some other class some other lecture next week.

So, these are the basic kind of factors there might be few more, but these are some of the basic factors which kind of governs, the what options what treatment you needs what treatment choices we are going to make for treating the waste water at our hand ok.

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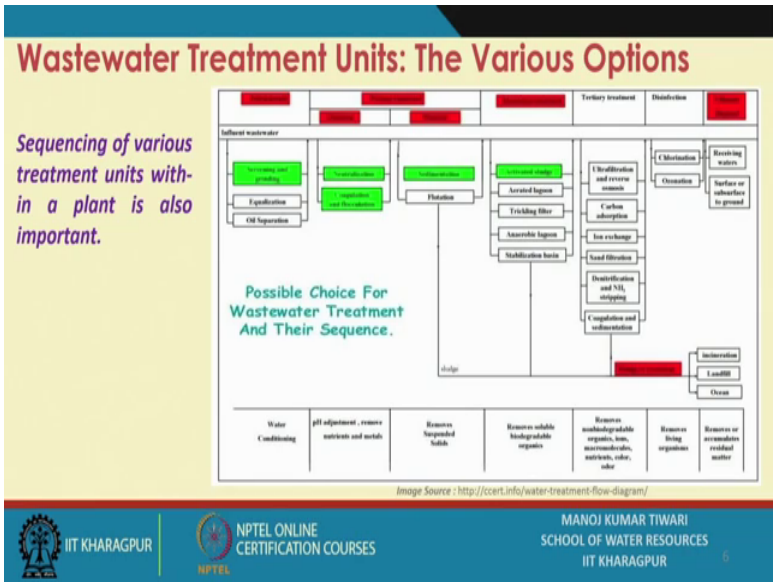

And then, once we make the choices, we parallelly we have to think about the sequencing of these various treatment units as well. So, with in a plant how these treatment units are arranged, how these treatment units are sequence. So, for say if you are planning to put a screen, you have to put it at the beginning itself there is no point of putting a screen post sedimentation tank because many of the things gets settle which can

be actually removed through screens will may get settle or may basically block your settling devises may cause hamper in the processes of settling itself. So, you want to trap that first.

So, that way you basically have to identify the location of each suitable units if you want to have a sedimentation base in plane sedimentation; you want to do it before aeration system, because you do not want to let us your elements go into the aeration and cause a abrasion and those kind of things to your aerator or block your nasals through which your if you are having a let us say defused aerator system. So, block your nasals through which you are pumping air.

So, those kind of challenges issues might come. So, that like depending on the work type of contaminant because as you say that, the domain of removal of says suspended domain of removal of a sedimentation basin or a greed chamber or a activated sludge process are different. But still it is preferable to keep then in a desired sequence, because if you replace that the other things which going to remove later may be is going to create problems in the your earlier unit that way. So, if you do not remove the sediments that is definitely going to create certain issues in your aeration systems ok.

So, that way we have to basically think of sequencing as well ok. So, the influent waste water we are having I really we should first go for screening and grit removal, then neutralisation chamber if need, and coagulation flocculation requirements if it is there, if it is not there its fine we can go to sedimentation activated sludge process. And that way we move from units to units ok. So, this is how the different treatment options or the different treatment approaches are picked and then are put through in a proper sequence in order to achieve the desired degree of treatment.

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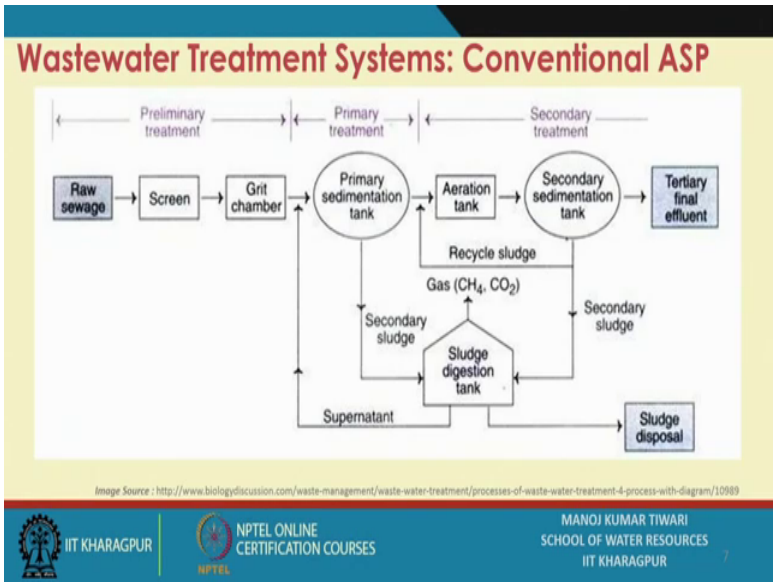

So, as we said, that we are going to talk about the variety of the treatment various treatment systems which are used in field. So, like there are a few alternate systems in the form of sequencing batch reactors or moving the bioreactors, membrane bioreactors. So, those kind of system are also there, which will be discussing this week, but the traditionally which we have been discussing earlier as well. The traditional or conventional systems the selection of the different units and their flow is something like this; what you are seeing on the screen.

So, in a conventional activated sludge process; which is by for the most popular system for treating the sewerage or treating the sewage system. So, you are having a raw sewage which eventually first go to this screen and to a grit chamber. So, screen removes the floating material grit removes the grit items, then it flows to your primary sedimentation basin form this primary sedimentation, the suspended materials are settled and over flow goes to aeration system. Now from aeration the again here the solvable BOD or COD whatever you call that is reduced and then it actually further overflows to the secondary sedimentation tank.

So, this will remove the floating materials these will remove the grit items, this is removes the suspended settle able materials, these removes the soluble BOD, these removes the biomass which is generated here.

So, those solids are also pushed through again and these which is comes here. So, these actually primary sludge, not secondary sludge. So, these primary sludge comes from here secondary sludge comes from here and then we have a sludge digestion tank or at times we may actually provide thickner. So, sludge thickner then sludge digestion tank, supernatant we can recycle to the primary basin. And the digested sludge can be taken for sludge disposal which usually happens in the conventional treatment systems.

Beyond that there is a option for tertiary or final treatment either tertiary treatment system or just final effluent is captured from this point onwards. And that way the like this final effluent is typically or usually discharge, in some a natural water bodies ok. So, that is what happens in a conventional activated sludge process ok.

So, these are the different units which are there. And this is the a specific sequence of unit and they have then their own, like this is for digestion of solid and removal of solid materials, this is separation of bio solids, this is your as we discussed for the removal of soluble BOD, then settable materials grit items or screens. So, that is how the a conventional activated sludge process is arranged and designed in the field.

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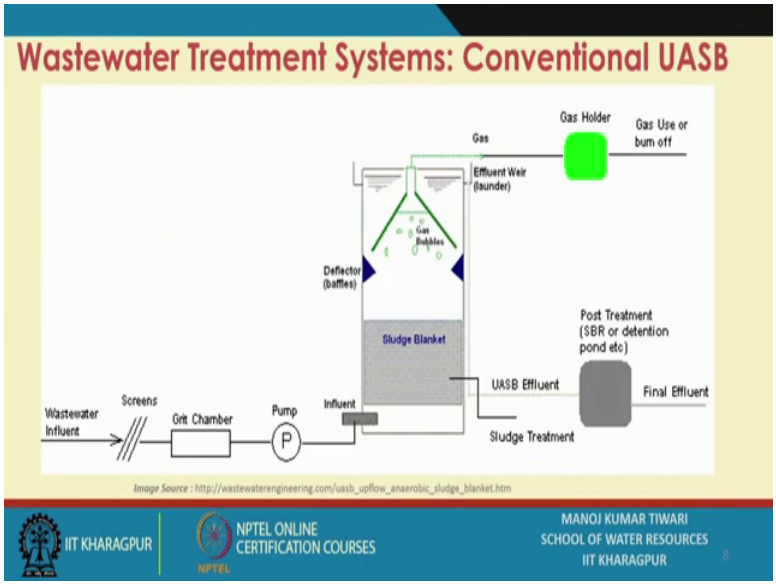

The conventional anaerobic's like activated fudge process aerobics system and the other popular system for the treatment of waste water and particularly in the industrial sectors as well, is UASB or affluent anaerobic sludge blanket which is anaerobic system. So, a conventional UASB will just have a screen then a grit chamber and from here it is

formed directly to the UASB reactor. We do not go for any primary sedimentation because settling is ensured here in these sludge blanket itself in kind of in the reactor itself we have a settling zone anywhere.

So, the influent is basically goes in the UASB reactor where it is treated and then the effluent goes to kind of; effluent is collected and it can be put through a another treatment unit or for final disposal depending on its quality. Sludge can be collected for sludge treatment which is process similar to the aerobic sludge ok. However, the generation is very little, so regular sludge withdrawal is not needed and the gas can be collected to a gas holder and then from this point onwards it can be either like collected for use, which is generally not there and most of the times it just flavoured of in the conventional systems ok; because gas collections becomes quiet costly affair. So, even though this is generated, but it is not that frequently used for.

So, these are the kind of screen, grit chamber, UASB system, gas system mechanisms, sludge handling system ok. As the typical units for a conventional UASB based system; UASB is just this much, but a UASB based treatment systems will have all these conventional unit. And then the since, UASB effluent has very low disorder oxygen its anaerobic process. So, there is no disorder oxygen in if you want to dispose of the fluent, we a particular to some river.

So, we must ensure that there is a adequate amount of disorder oxygen present in the water and for that purpose, it is often kept in a kind of a open pond, for acquiring certain oxygen before it is disposed off. So, the post treatment which may be polishing pond those kind thing it can kept for sometime or if in industrial waste water systems if the effluent is still having quite high organic load so it can be processed through another aerobic system. So, that is what is the typical to conventional USB system.

So, we will conclude this discussion for the lecture here. And in the next class then will be discussing about, some of the alternate treatment schemes alternate treatment systems that is there which these days people are kind of preferring to use at times; or maybe even if not preferring so opting for using those things as well along with these conventional systems.

Thank you for joining and see you in the next class.