Biological Process Design for Wastewater Treatment
Professor Vimal Chandra Srivastava
Department of Chemical Engineering
Indian Institute of Technology, Roorkee
Lecture: 40
Common Effluent Treatment Plant (CETP)

Welcome everyone in this NPTEL Online Certification Course on Biological Process Design for Wastewater Treatment. So, we have come to the virtually end of this course and we are going to today learn the last section in this course and that last section is common effluent treatment plant, CETP. And CETP are used a lot.

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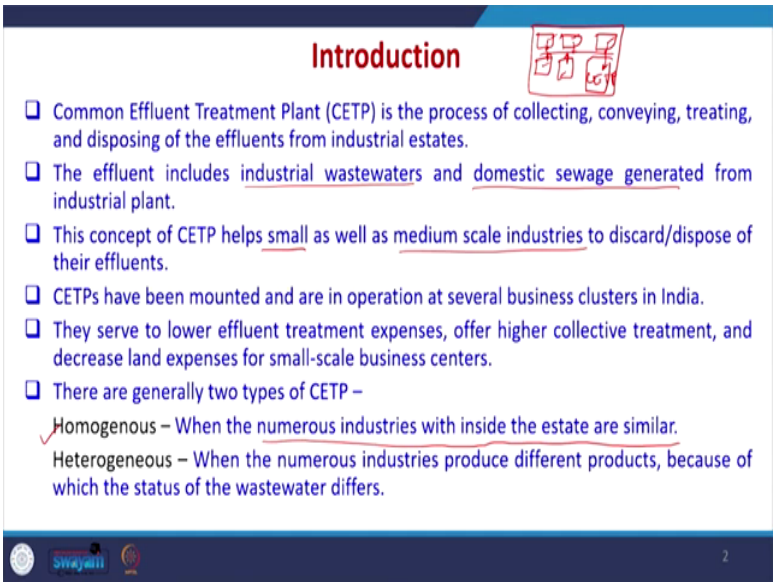

The common effluent treatment plant is the process of collecting conveying treating and disposing of the effluent from industrial states. So, what does it mean? So, we may have some special economic zone and a number of industries may be there. So, there are a number of plots, which have number of industries.

So, what we do is that in the common effluent treatment plant, we have a common effluent treatment plant, these member industries they treat the wastewater up to a certain level and then they will discharge to a common line which will go to the common effluent treatment plant, the CETP. So, and these industries may be same in nature or different in nature.

So, certainly, they will do some primary treatment depending upon the type of wastewater which is discharge and then it will go to CETP. The advantage is that they do not have to incur that much cost with respect to treatment and they do not require space also which is

required for installing all the treatment plant units. So, this is the method that is why the common effluent treatment plants are always used and they are preferred.

So, the effluent which may be taken may include industrial wastewater, domestic sewage generated from the industrial plant. So, both can be taken care. This concept of CETP helps small as well as medium scale industries to discard and dispose of their influence without much treatment. So, CETPs have been mounted and are in operation at several business clusters in India and worldwide.

They serve to the lower effluent treatment expenses and offer high collective treatment and decrease the land expenses for small scale business centres. So, the industries do not have to have very high land for treatment of the wastewater that will be taken care of by the CETP. There are generally two types of CETPs, homogeneous, when the numerous industries with inside the state are similar.

So, when all the industries are similar in nature, we can have homogeneous CETP. We can have heterogeneous CETP, when the industries produce different products and their wastewater effluents has different characteristics.

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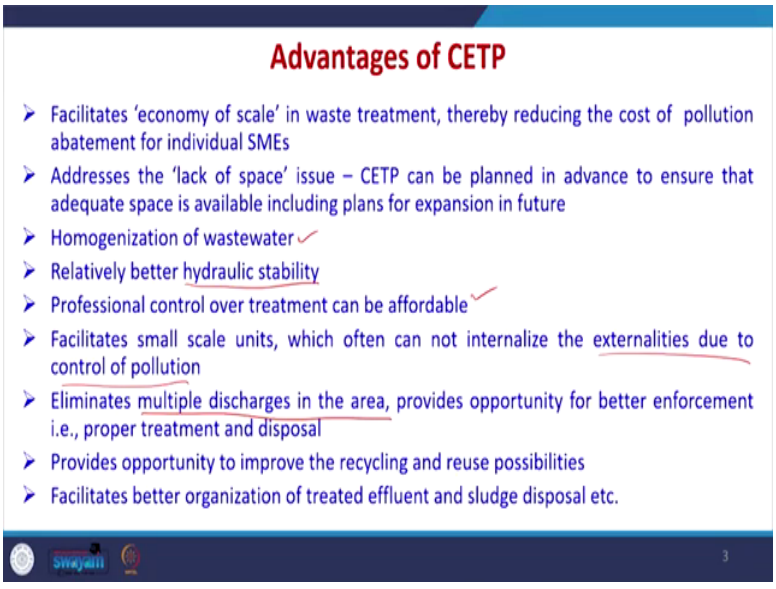

Now, the advantages of CETP, CETP facilitates economic of scale in waste treatment, thereby reducing the cost of pollution abatement for individual SMES. The addresses the lack of space, it addresses the lack of space because the individual industries may not have enough

space for treatment and. So, they can do very minor treatment or no treatment and discharge the water to CETP where all the treatment can be done.

Also, homogenization of wastewater. So, all the industries will discharge water. So, wastewater will become more homogeneous in nature that can be taken care of, but in the case of heterogeneous CETP sometimes problem may also happen, if some, if suppose somebody discharges suddenly large amount of surfactant into the wastewater.

So, CETP may not be able to cater to that. So, that problem may also happen but, it is generally the homogenization more happens. Relatively, better hydraulic stability, professional control over treatment can be affordable because there will be professionals which will be hired in the CETP. It facilitates small scale units which often cannot internalize the externalities due to the control of pollution.

So, if the pollution aspect can be taken care of for the small industries. Eliminates multiple discharges in the area, because if the many industries are there. So, they may be discharging individually. So, in place of that, they are discharging to a common pipeline network and which is going to CETP. So, that means it eliminates multiple discharges.

So, overall, the water can be more carefully taken care of. Provides opportunity to improve the recycling and use possibilities, facilitates better organization of treated effluents and sludge disposal, etcetera. So, planning of CETP is very important. So, there are various inputs and outputs for choosing the treatment scheme, okay.

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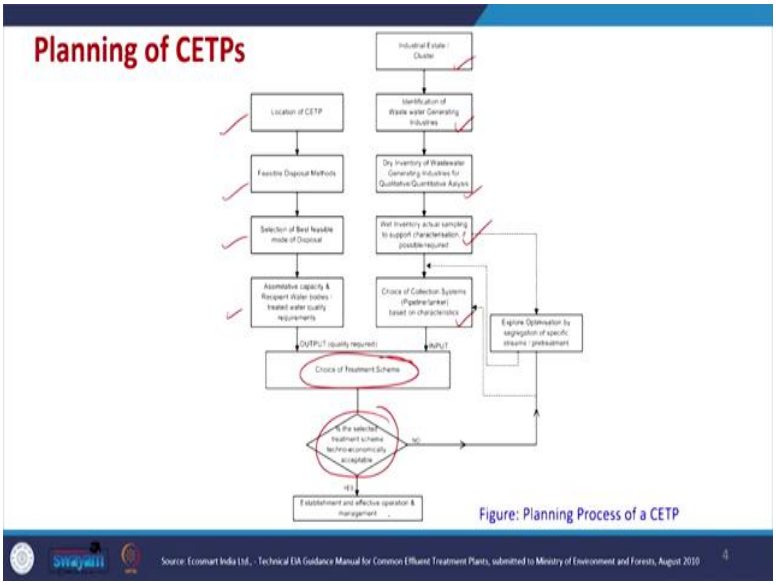

So, location of CETP, feasibility of the disposal methods, selection of best feasible mode of disposal, and then also the, checking the capacity and recipient water body is treated water quality requirements, all these are the major factors which are taken into account with respect to choice of treatment scheme.

So, this, the inputs may be industrial state or clusters, identification of various types of wastewaters which will be generated in the industries, dry inventory of the wastewater, similarly wet inventory, then choice of collection systems whether pipeline, tanker, etcetera, all these are input, and the output is with respect to after treatment what will go. So, if the selection treatment scheme techno economically acceptable, no, so we have to explore the optimization of different things, if yes, we can go for establishing the CETP.

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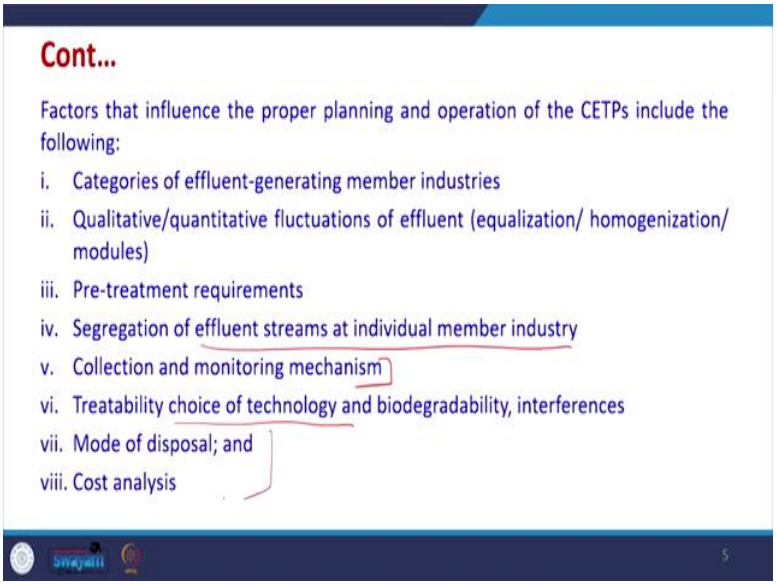

Factors that influence the proper planning and operation of CETPs include the categories of effluent generating member Industries, qualitative and quantitative fluctuations of effluent which is likely possible. What will be the pre-treatment requirements? Whether we have to segregate effluent streams at individual member industries itself or not?

A collection and monitoring mechanism because collection is very important and also, we have to see that monitoring of the individual effluent is also done. Suddenly, somebody is discharging very heavily load. So, it will affect the wastewater quality. So, that similarly we have to maybe alter the parameters at the CETP. So, this is very important.

The treatability choice of the technology and biodegradability interferences, etc., have to be taken care of. Mode of disposal and cost analysis. So, all have to be performed for CETP.

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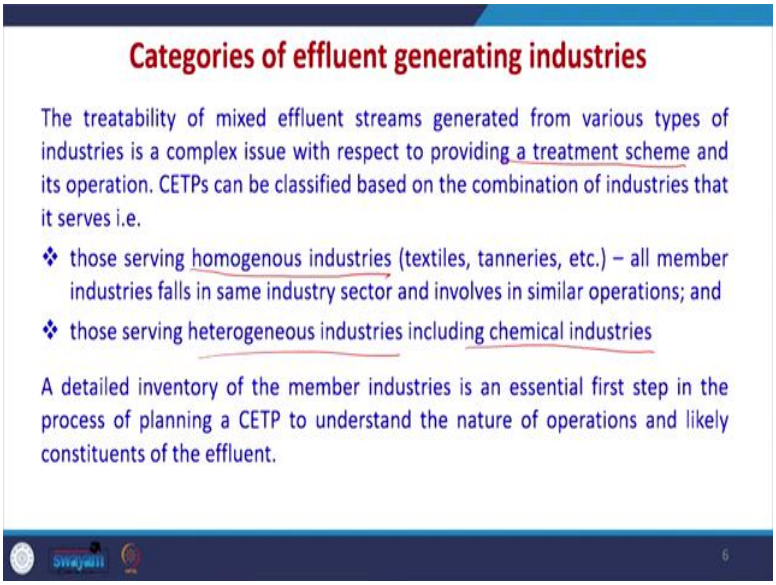

The categories of effluent generating industries. The treatability of the mixed effluent streams generated from various types of industries is a complex issue, with respect to providing a treatment scheme and its operation. The CETP can be classified based upon the combination of industries. Those already told, CETPs may be homogeneous, those who are serving homogeneous industries like textile, tanneries, etc.

So, all member industries fall in the same industry sector. So, the CETP will be called as homogeneous CETP. Those, the CETP may be heterogeneous serving, heterogeneous industries including chemical industries, so for this these issues may be complex. So, detailed inventory of the member industry is an essential first step in the process of planning of a CETP to understand the nature of operations and likely constituents are the effluent.

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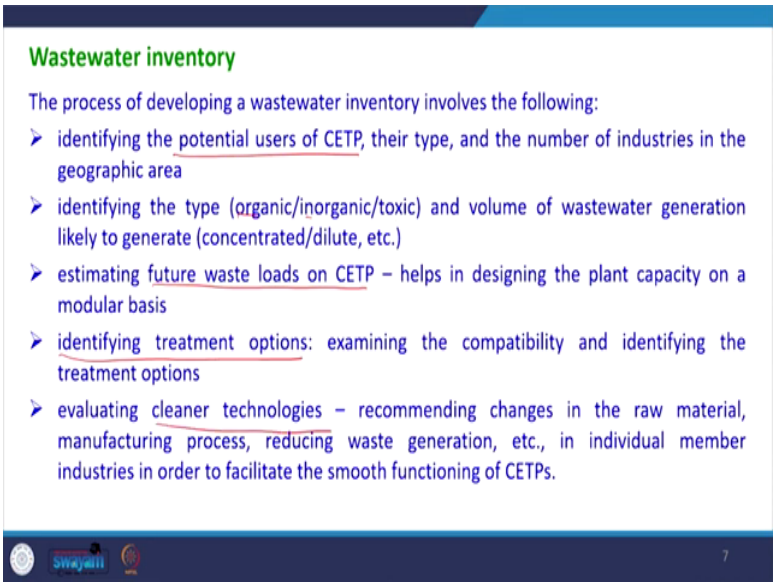

Then the wastewater inventory. The process of developing a wastewater inventory involves the following, identifying the potential users of CETP, their types and the number of industries in that geographical area. Identifying the type whether it is organic, inorganic toxic, and volume of wastewater generated, whether it is concentrated, dilute, etc.

Then estimate the future waste load also in the industry, maybe some new industry may come up in the cluster, or the expansion may happen, these also have to identified. Identifying the treatment of options, examining the compatibility and identifying the treatment options is important. Then evaluating the cleaner technologies, whether recommending changes in the raw material, manufacturing process.

So these industries may be suggested to go for cleaner production technologies, so that they may change the raw material also they may change the manufacturing process. Thus, they will be able to reduce the waste generation in individual member industries in order to facilitate the smooth functioning of the CETP.

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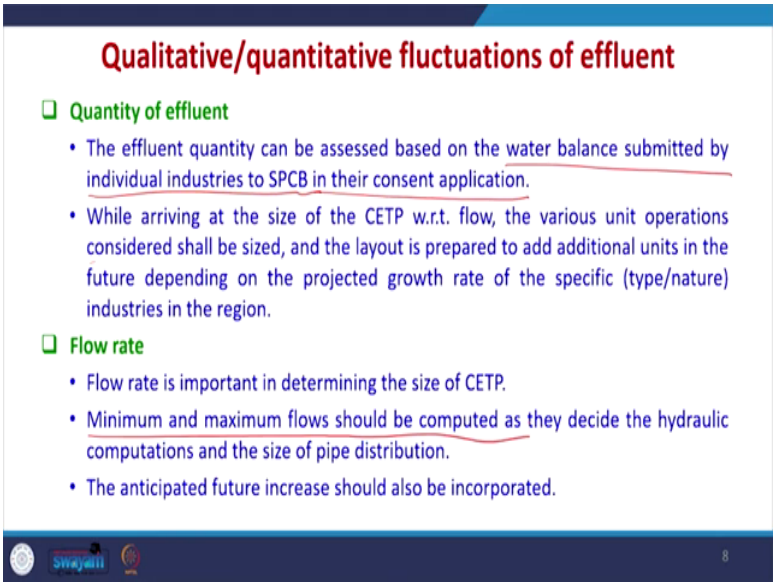

Now, qualitative and quantitative fluctuations of effluent, the quantity of effluent. The effluent quantity can be assessed based upon the water balance submitted by the individual industries to State Pollution Control Board in their consent application. So, from that, we can tentatively know that what the quantity of effluent that will be generated is.

While arriving at the size of CETP with respect to flow the various unit operations considered shall be sized, and the layout is prepared to add additional units in future depending upon the project growth rate of the specific industries in the region. So, we, in the layout the CETP plant in such a manner that we should be able to add more units in future if the effluent production increases because of the expansion of industries or addition of more industries.

Flow rate, the flow rate is important in determining the size of CETP. So, minimum and maximum flows should be computed beforehand. So, as to decide the hydraulic computation and the size of the pipe distribution, because the water will be collected depending upon the flow rate, from different industries. So, the conveying system water, wastewater conveying system is very important, so size of the pipe their distribution, etcetera is very important. The anticipated future expansion should also be taken care of.

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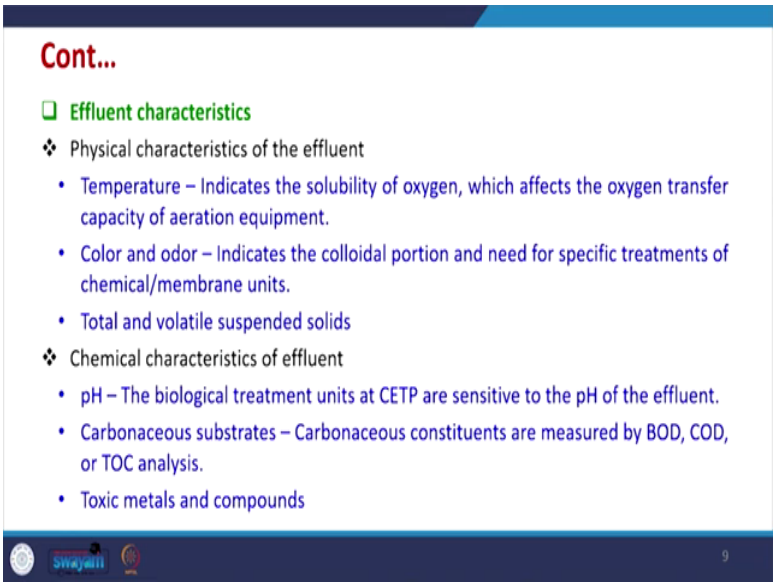

The effluent characteristics physical characteristics of the effluent, whether temperature colour, odor, total solids, total volatile solids, all have to be tentatively understood beforehand. Also, the chemical characteristics pH, the amount of different COD, BOD, all those things also have to analyse.

Also, we need to beforehand know that whether toxic metals will be present in the water or not. So, whether we have to go for tertiary treatment, if tertiary treatment we have to go what type of tertiary treatment has to be adopted, within the biological treatment which method will be preferred whether aerobic anaerobic, within aerobic and anaerobic which one will be better.

So, all these will depend upon the physical characteristics of the effluent, chemical characteristics of the effluent. So, this we have to see.

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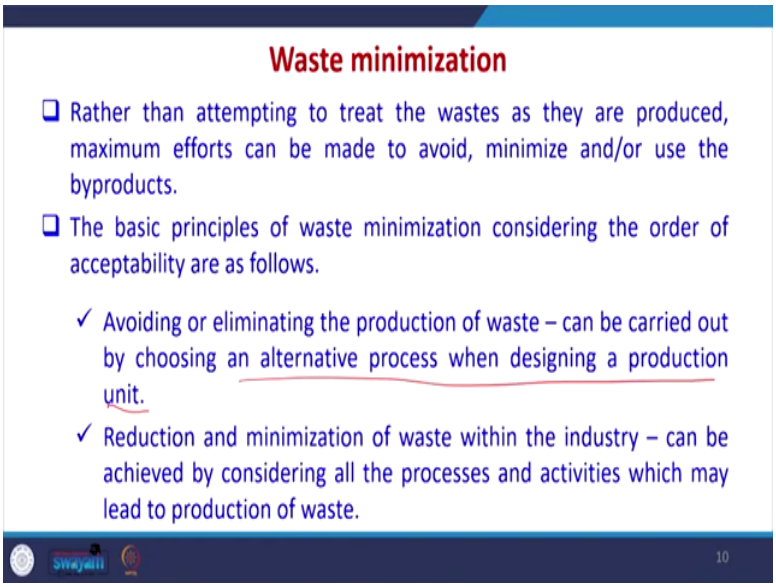

Now waste minimization rather than adapting to treat the waste as they are produced, maximum effort has to be made to avoid minimize the use or use the by-products. So, we have to see that minimum possible waste is produced and if it is possible, we have to reuse it.

The basic principles of waste minimization have to be used, avoid or eliminate the production of waste; this can be carried out by choosing alternative processes when designing the production unit. So, clean production options have to be taken care of. Reduction and minimization of waste within the industry has to be considered, so that the CETP load is minimum.

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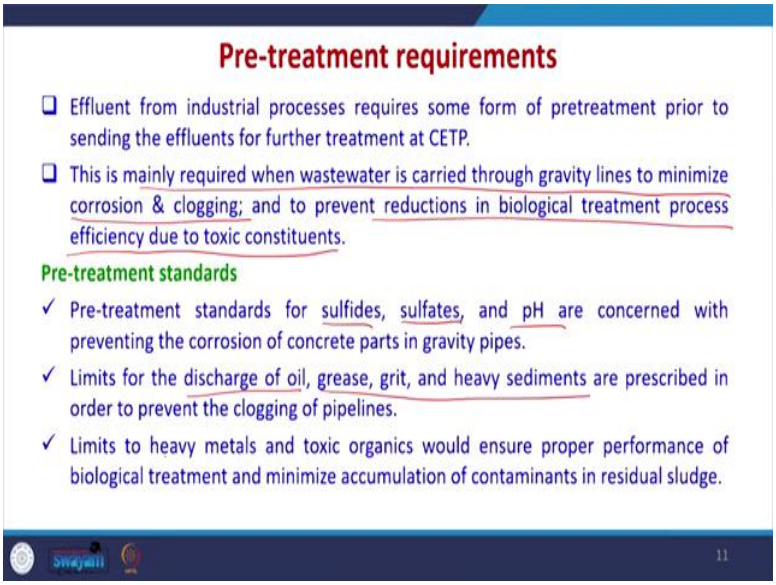

Now, when the effluent is coming within the CETP, certainly, we have to go for various treatment options. So, there are various pre-treatment requirements. So, effluent from industrial processes requires some form of pre-treatment prior to sending the effluent for further treatment at CETP.

This is mainly required when wastewater is carried through gravity lines to minimize the corrosion and clogging. So, some primary or pre-treatment at individual industry level is required and it helps in the reduction in the biological treatment processes efficiency due to the presence of toxic constituents.

So, if some specialty types of pollutant are present, if the pollutant is unique in nature, which is not present in the industrial clusters from other industries, so that pollutant, if possible, that should be maximum bit taken care of in the primary industry itself. Now this is very important. So, pre-treatment standards for sulphides, sulphates, pH are concerned with preventing the corrosion of concrete part in the gravity pipe.

Limits further discharge of oil, grease, grit, and heavy sediments are prescribed. Limits to heavy metals toxic organics are also prescribed, so that the CETP is not overburdened with respect to treatment.

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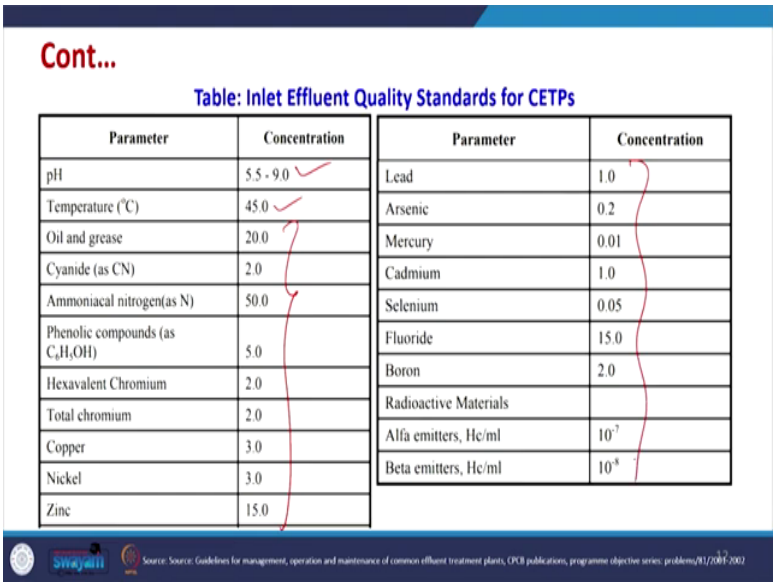

The inlet effluent quality standards for CETP is like this. So, it is possible that the pH should be in this temperature should be 45 degree or below, and these are the various type of contaminants which are allowed to be present in the CETP inlet effluent quality. So, these can be taken care of in the CETP.

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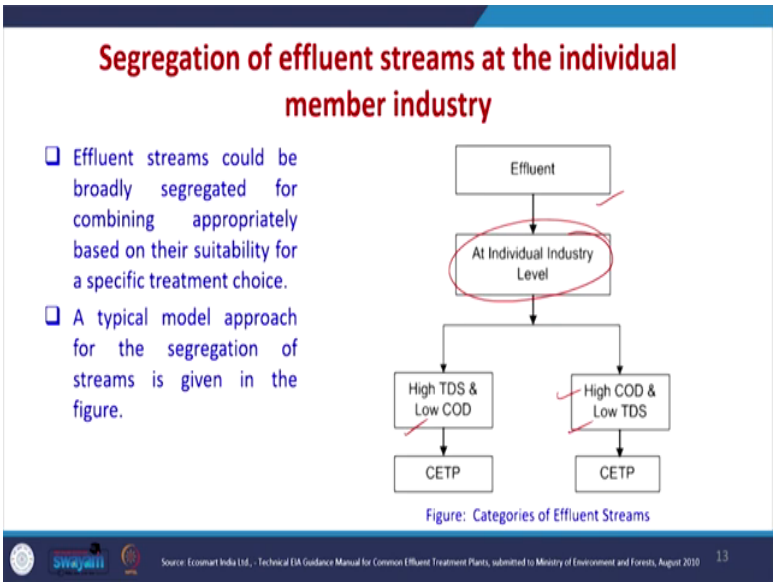

Now, segregation of effluent streams at the individual member industries. So, effluent streams teams could be broadly segregated for combining appropriately, based upon the suitability of specific treatment choice. So, effluent at the individual industry level, they have to be separated. So, high TDS low COD, high COD low TDS.

So these type of categorization may be done. And also like we can have a separate pipe for sewage effluent and industrial effluent. So, these there are different model approaches which are there and some primary treatment may have to be done at the industry, individual industry level itself.

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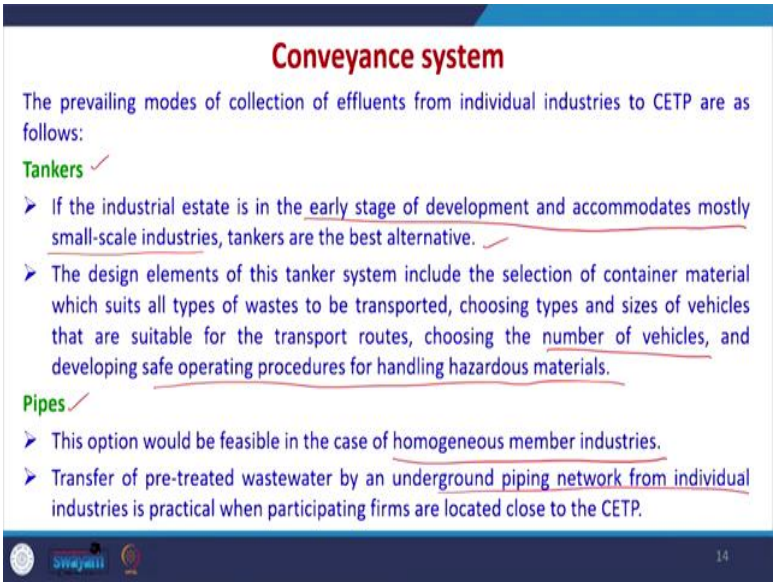

Now, conveyance system. How the water will be conveyed from individual industry to the CETP? So, we can use tankers, we can use pipes. If the industrial state is in early stage of development and accommodates mostly small-scale industries, tankers are best alternatives.

So, design elements of this tanker system will include, the selection of container material which shoots all type of waste to be transported, choosing type and size of vehicle that are suitable for transport routes, choosing the number of vehicles and developing safe operating procedures for handling hazardous material. So, in the initial stage when early stage is there with respect to development tanker is a better choice. Then we can go later on for the pipes.

This option will be feasible in the case of homogeneous member industries. Transfer of pre-treated wastewater by and underground piping network from individual industries is practical when the participating firms are located very close to CETP. So, this way we will be able to transport the water from individual industries to CETP.

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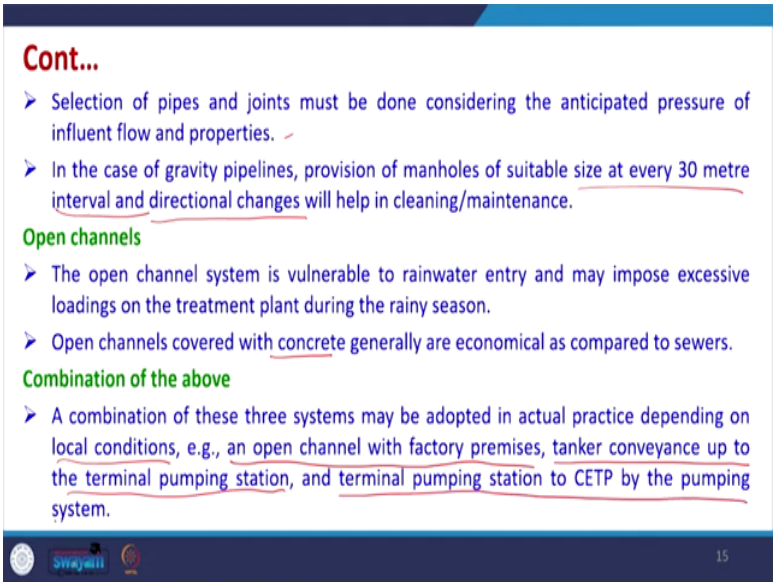

Selection of pipe and joints must be done considering the anticipated pressure of influent flow and properties. In the case of gravity pipelines, provisions of manholes of suitable size at every 30-meter interval and at the directional changes will help in the maintenance of the pipe, this is there. We can go for open channel also, but it is vulnerable to rain water entry may impose excessive loadings on the treatment plant during the rainy season.

So, open channels have to be covered with concrete and they are generally economical as compared to sewer lines, but they have problems also. So, combination we can use, the combination of above. The combination of these three conveying systems may be adopted in actual practice depending upon the local conditions.

So, like example is that, an open channel with factory premises, within the factory premises, then the tanker conveying system up to the terminal pumping station and then the terminal pumping station to CETP pumping system. So, this way, we can adopt any three or we should prefer tanker or pipe. So, this is there.

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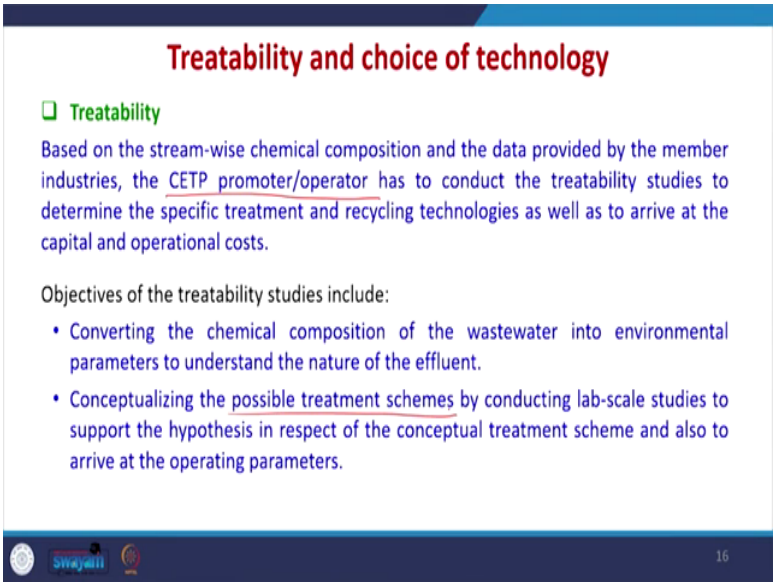

Now, treatability and choice of technology at CETP, this is important. So, based upon the stream wise chemical composition and the data provided by the member industries, the CETP promoter operator has to conduct a treatability study to determine the specific treatment and recycling technologies as well as arrive at the capital and operational cost.

So, objectives of the treatability will include, covering the chemical composition of the wastewater and into the environmental parameter to understand the nature of the effluent. So, chemical composition has to be taken care of, it should be properly understood, what are the various problems associated with those chemical compositions?

What are the interference during the treatment? All those things should be well understood. Then we should conceptualize the possible treatment schemes by conducting life scale studies to support the hypothesis with respect to conceptual treatment scheme.

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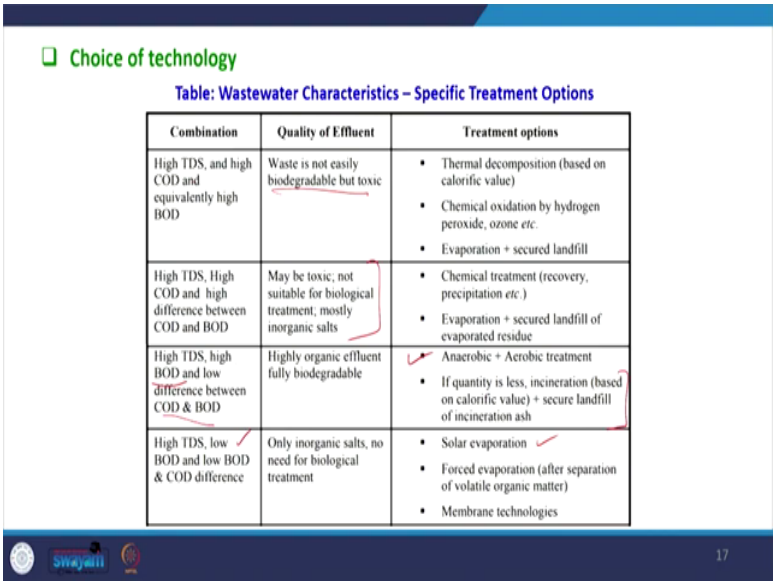

Then wastewater characteristics and some treatment options, we have studied all these things in detail in this lecture series as well as in another course on physicochemical treatment. So, combination, if the combination is high TDS high COD and very high BOD, waste is not easily biodegradable but toxic.

In this case thermal decomposition, chemical oxidation, evaporation, secured landfilled, etcetera. If high TDS, high COD, high difference between COD, it is may be toxic not suitable for biological treatment, mostly inorganic salts or chemical treatment evaporation and this. If high TDS, high BOD is there, but low difference between COD and BOD, that means we should go for anaerobic plus aerobic treatment.

If the quantity is less, we can go for incineration, secure landfill, etc. If high TDS low BOD and low BOD and COD difference, we should go for solar evaporation, forced evaporation. So, there are many treatment options which are available depending upon that we have to decide.

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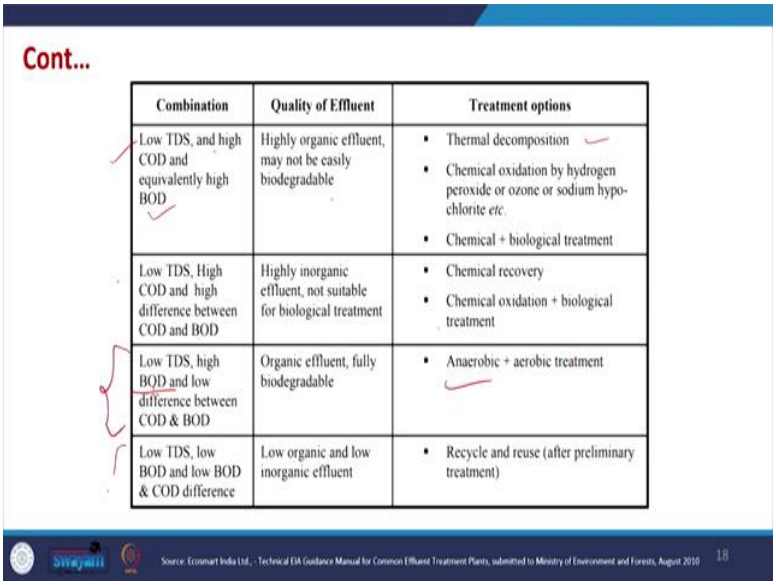

Similarly, low TDS, high COD, equivalently high BOD, so it is highly organic effluent, may not be easily biodegradable to go for thermal decomposition, chemical oxidation, chemical plus biological treatment. If low TDS, high COD, high difference is there between, again chemical recovery and chemical oxidation.

If low TDS high BOD is there and low difference go for anaerobic aerobic treatment which is will be most common thing. Then low TDS, low BOD, low BOD COD difference recycle and use after preliminary treatment. So, there are various options we have to check and depending upon that treatment has to be adopted.

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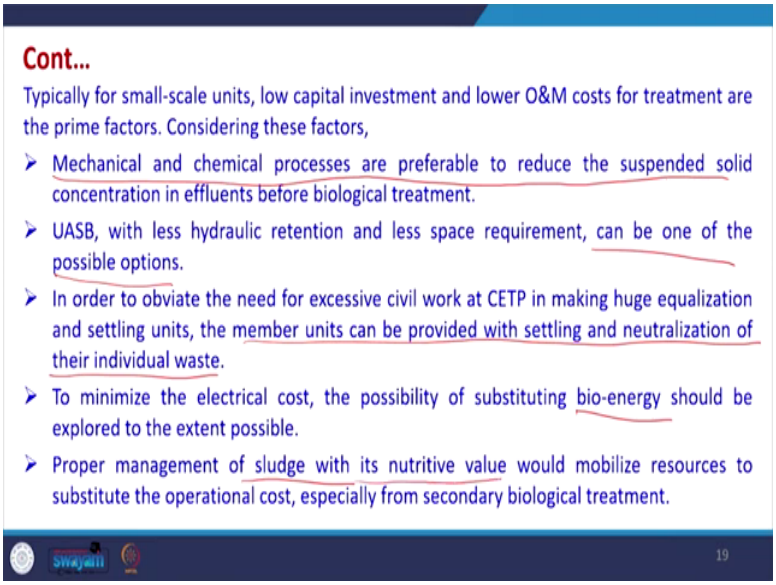

Now, typically for small scan units, low capital investment and lower operation and maintenance cost for treatment are the prime factors. So, considering these factors mechanical and chemical processes are preferable to reduce the suspended solid concentrations in the effluent before biological treatment. UASB, with less hydraulic retention time, less space requirement, can be one of the possible options.

In order to obviate the need of excessive civil work at CETP in making heat equalization and settling units, the member units can be provided with the settling and neutralization units. So, this unit may be at the member unit itself. To minimize the electrical cost the possibility of substituting the bioenergy should be explored.

So, can we generate bioenergy and can we use the bioenergy that has to be checked. Proper management of sludge with its nutritive value would mobilize resources to substitute the operational cost, especially from secondary biological treatment. So, sludge management is a big challenge and that has to be taken care of.

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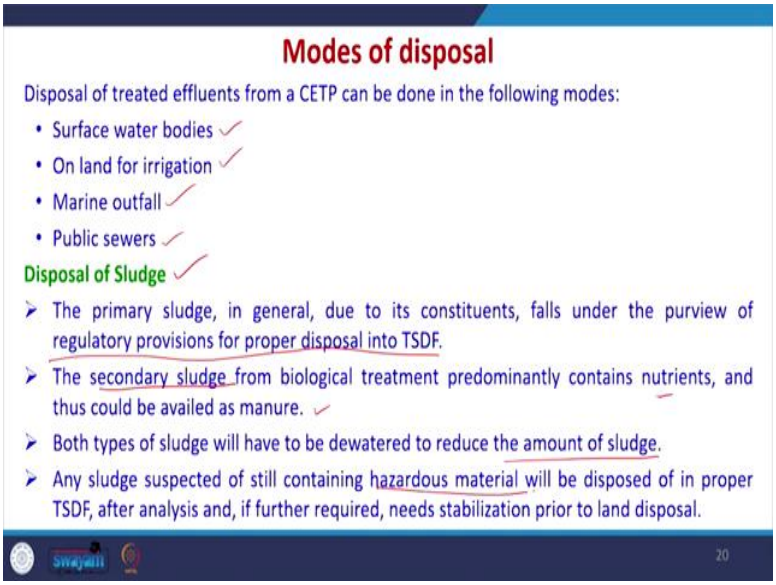

Wastewater after treatment also has to be disposed of. So, disposal of treated effluent from CETP can be done any of the modes, surface water bodies, on land for irrigation, marine outfall, public sewers, so this is important concern depending upon the treatment that has been done, it is possible that they may be forced to reuse the water.

So, the primary sludge, in general, disposal of sludge is also an issue. Primary sludge in general due to its constituent, falls under the purview of regulative provisions for proper disposal of TSDF. The secondary sludge from biological treatment predominantly contains nutrients, thus would be available as manure.

Both types of sludge would have to be dewatered to reduce the amount of sludge. So, this is very important. Any sludge suspected of still containing hazardous material has to be disposed of in a proper TSDF after analysis. So, this has to be taken care of.

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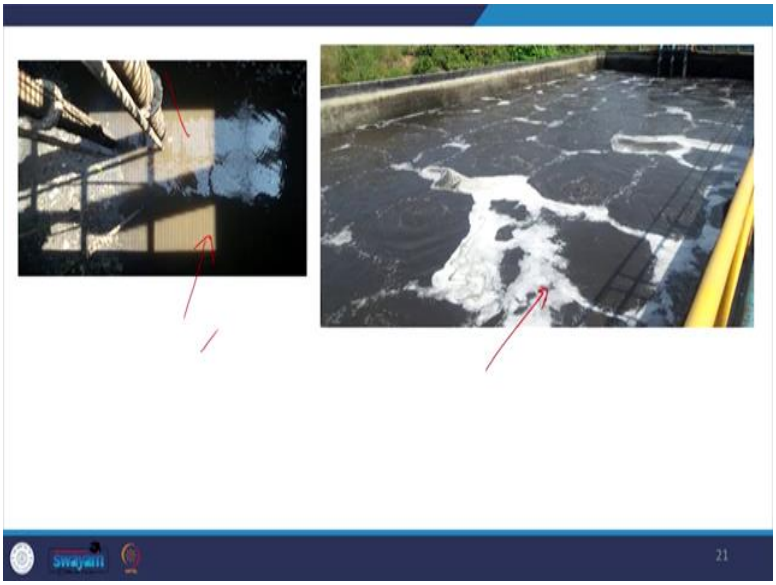

Here, some photographs are shown here. So, we can see here, the wastewater from different industries is coming to a, this particular unit where the wastewater is achieved. This is after some oil and grease, similar other things, this has been treatment in an aerobic reactor activated sludge process. So, this is aerobic reactor.

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We can have a centrifuge first wastewater separation from the sludge. So, you can see the sludge falling into here and this rickshaw will be further taken off where the sludge will be disposed. We can have clarified water tank from here, this water has to be treated in the like

activated carbon filter or sand filters the one which is shown here, another sand filter shown here.

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So, there are different possibilities, we can see the sludge drying beds which are here. So, these are the sludge drying beds, where the drying is being done, after that they have to be probably disposed of. We have already studied the in detail how to take care of the sludge management issues, they are. Since huge amount of sludge is produced in the CETP, all those things have to be taken care of.

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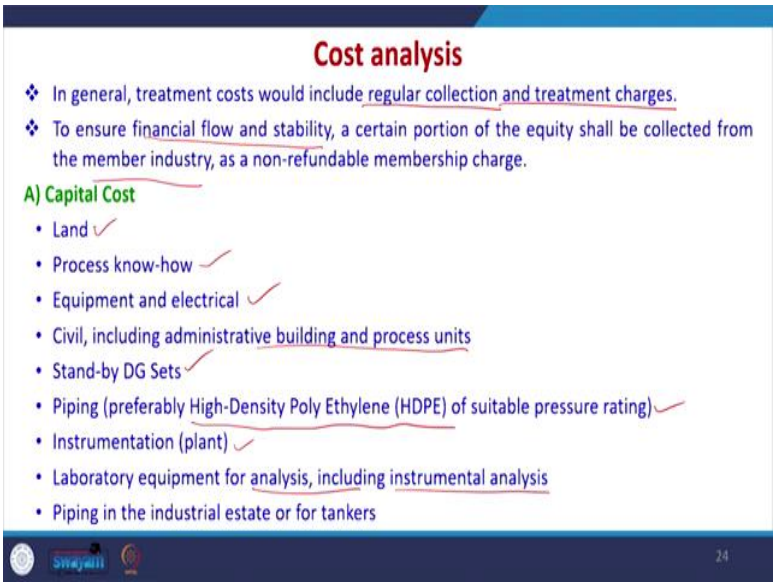

Now, cost analysis is also very important in case of CETP. In general, the treatment cost will include the regular collection and treatment charges. To ensure financial flows and stability a certain portion of the equity shall be collected from the member industry, and so as a membership charge. So, the capital cost for a CETP will include land process know-how, the technology equipment and electrical cost, civil, including administrative building and process units.

Stand-by DG sets, because we cannot stop the operation, so DG sets have to be there. Pumping, preferably high-density polyethylene of suitable pressure rating have to be used. Then instrumentation at the plant laboratory equipment for analysis including instrumental analysis, etcetera. So, this laboratory has to be there at the CETP for analysing the inlet BOD, Outlet BOD, inlet COD, outlet COD, all those inlet and outlet parameters, piping in the industrial state are for tankers, all these will come into the capital cost category.

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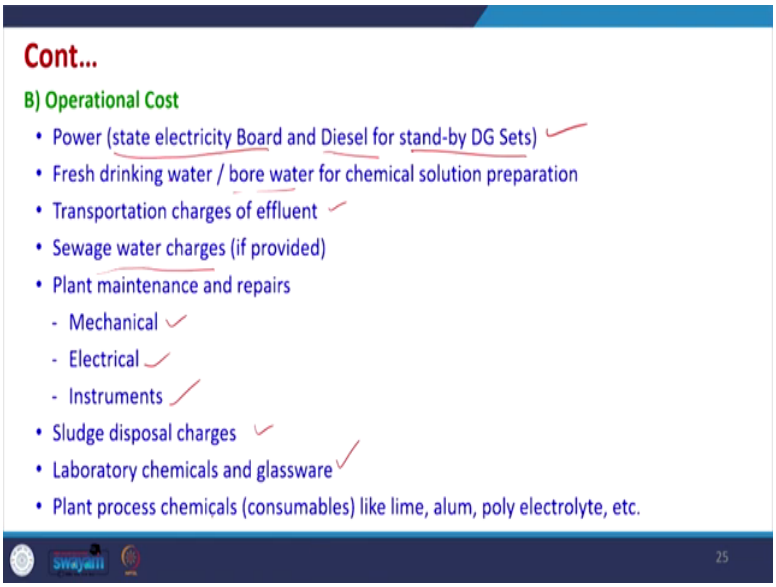

Similarly, operation cost will also be there power, the state electricity board and diesel for stand-by diesel sets. So, power requirement for that operation cost is required. Fresh drinking water, bore water for chemical solution preparation, transportation charges for effluent, then sewage water charges if provided, then plant maintenance and repairs including mechanical electrical and instruments, then sludge disposal charges will be there, laboratory chemicals and glassware charges.

Plant process chemicals including consumables like lime, alum, poly electrolyte, etc., all the coagulant, flocculant that we are using, they will also come under the category of operational

cost. So, these are the various costs which are associated with both fixed and operational costs.

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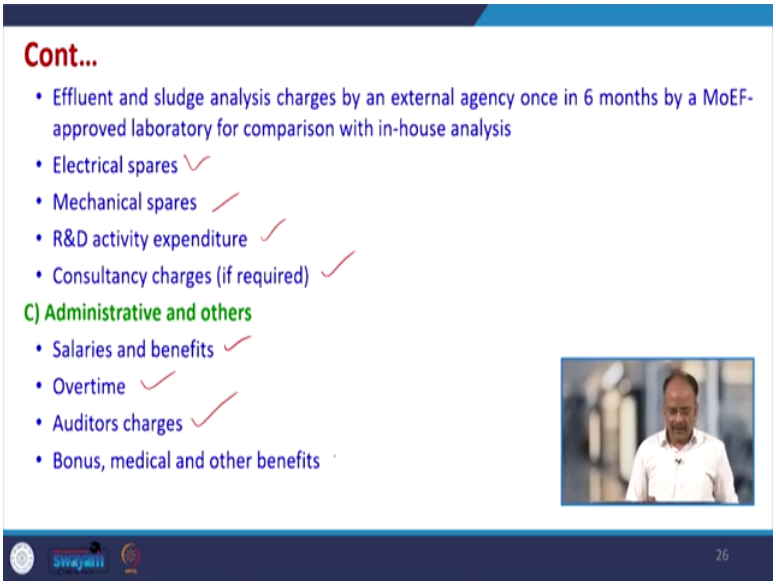

Similarly, in the operational cost effluent and sludge analysis charges, electrical spares, mechanical spares, R&D activity expenditures, consultancy charges, if required, they will also come into picture. Other administrative and other type of charges will also come into picture because we have to pay for the salary and benefits to the workers.

Over time charges, auditors will be appointed. So, we have to go, give charges to auditors also, bonus medical and other benefits. So, CETP has all the three types of charges, capital cost, operational cost, and administrative and other cost and this we have to plan beforehand. And we have to see depending upon this cost we have to levy the membership charge on the member industries then we can go for, finally the CETP will be sustainable.

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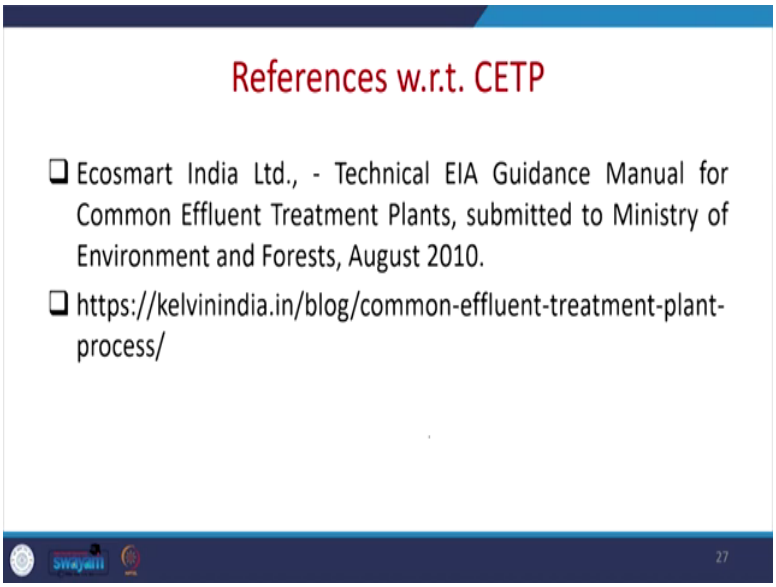

There have been many references, which some of the references which are been used mainly are given here you can refer to CETP. Now, since we have come to the end of this lecture, for Biological Process Design for Wastewater Treatment, so let us summarize that what we have studied is, the content which have been covered in this course.

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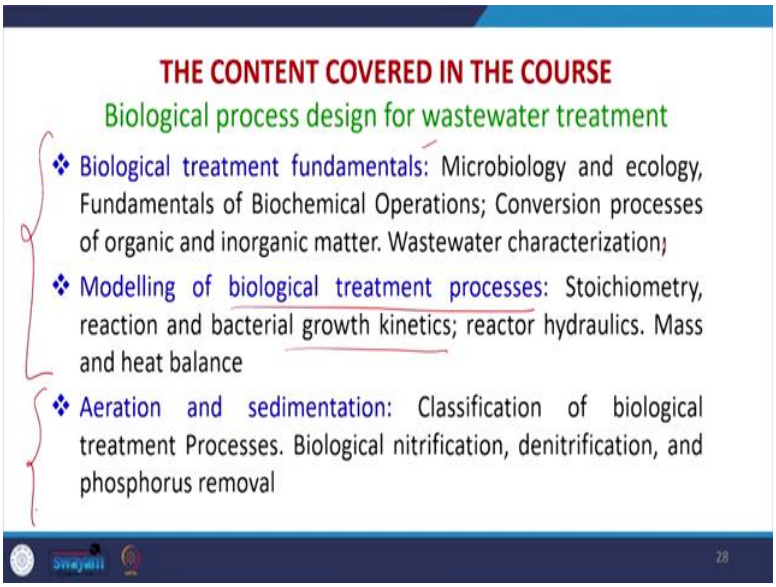

So, in the course we have first started with biological treatment fundamentals including microbiology and ecology. We studied the fundamentals of biochemical operations including the conversion processes for organic and organic matter, wastewater characterization we studied in great detail. After that we studied the modelling of biological treatment processes

including the stoichiometry, reaction and bacterial growth kinetics we studied, we studied reactor hydraulics including mass balance also.

Later on, we started studying the treatment of wastewater, in general we studied. And after treatment we divided that into different sections. So, up till now we studied the basics, after, from here we studied the, started studying that wastewater treatment in detail. So, in the, initially we studied aeration sedimentation including biological treatment process, biology nitrification, denitrification, phosphorus removal. So, all the things we studied.

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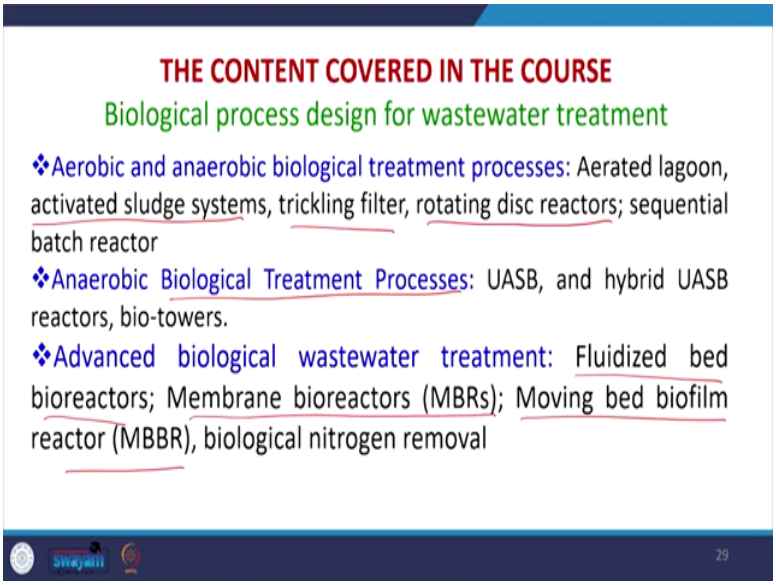

Later on, we studied in detail the aerobic and anaerobic biological treatment processes including aerated lagoon, activated sludge system, trickling filter, rotating disc reactor, sequential batch reactor, so all these reactors we have studied. Later on, we studied the anaerobic biological treatment processes including UASB and hybrid UASB reactors, etcetera.

After that, we studied advanced biological wastewater treatment systems. So, these included fluidized bed bioreactors, membrane bioreactors, moving bed biofilm reactors, we studied biological nitrogen removal in these advanced biological wastewater treatment options.

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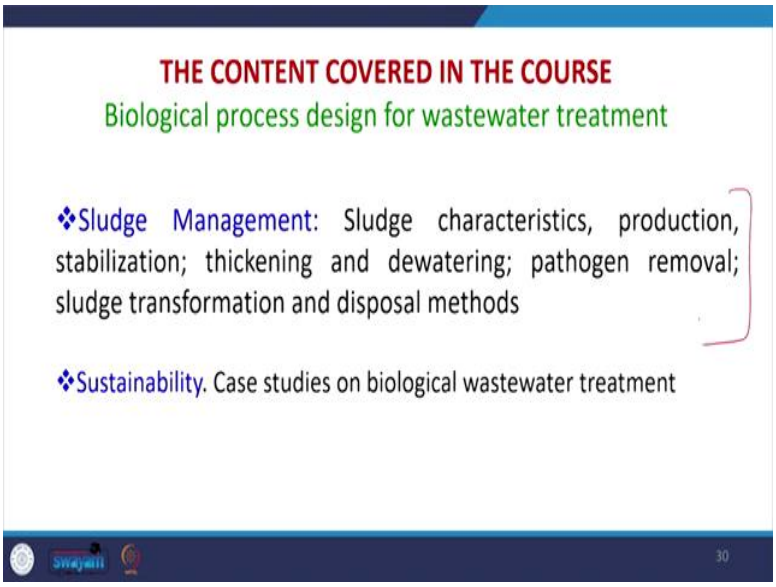

We studied a lot with respect to sludge management. So, sludge characteristics, production, stabilization, thickening, dewatering, pathogen, sludge transformation and disposal methods, all we studied because lot of sludge is generated during biological treatment. And we should study the sludge management because this is very important aspect of wastewater, biological wastewater treatment.

So, all of these we have studied in detail. Lastly, we studied the sustainability some concepts with respect to sustainable development cleaner production EIA. And later on, we studied few studies on the case studies with respect to wastewater management in a dairy industry, in slaughterhouse, and lastly, today we studied CETP.

There are some more studies that have been reported in another lecture of mine on physical chemical treatment of wastewater. And in those we have studied another physical chemical operations including advanced oxidation processes in detail. So, you can refer to those lectures also if you are interested.

And this way, we have come to the end of this lecture series, and hopefully you will have learned a few things in this biological process design for wastewater treatment.

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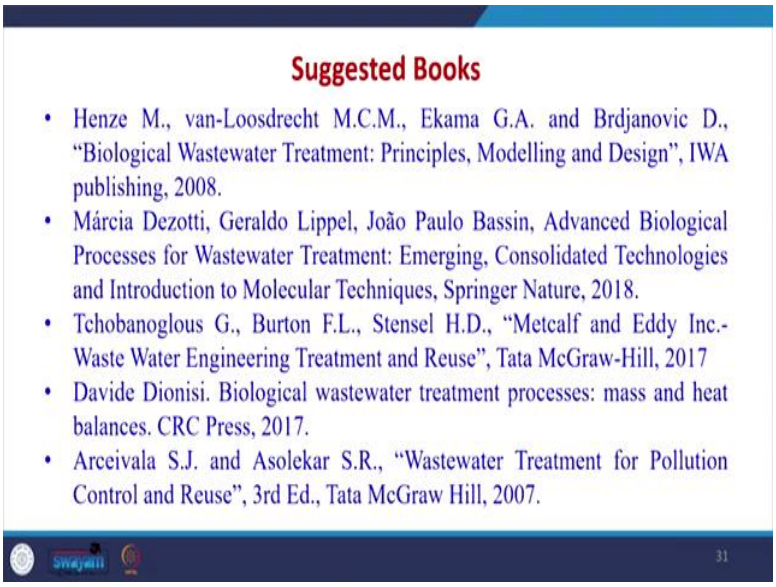

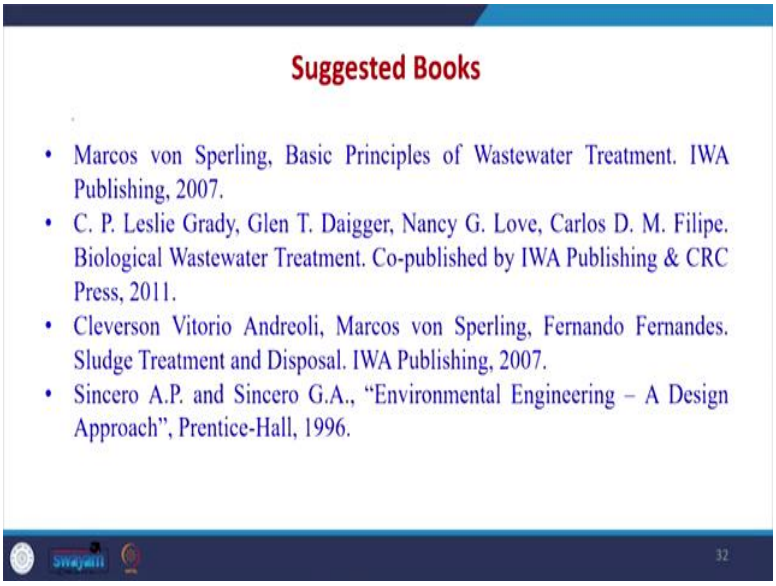

Certainly, you can always refer to many books which are listed here some of them. So, these are the suggested books for further reading. These books are very good. You can always refer to, these are, there are some other books that I have listed here. These books I have taken use in preparation of the slides as well as in the delivery of lectures.

So, you can always refer to these books. I think these books will be helpful in further understanding the topics. With this I will end this lecture series. Thank you very much.