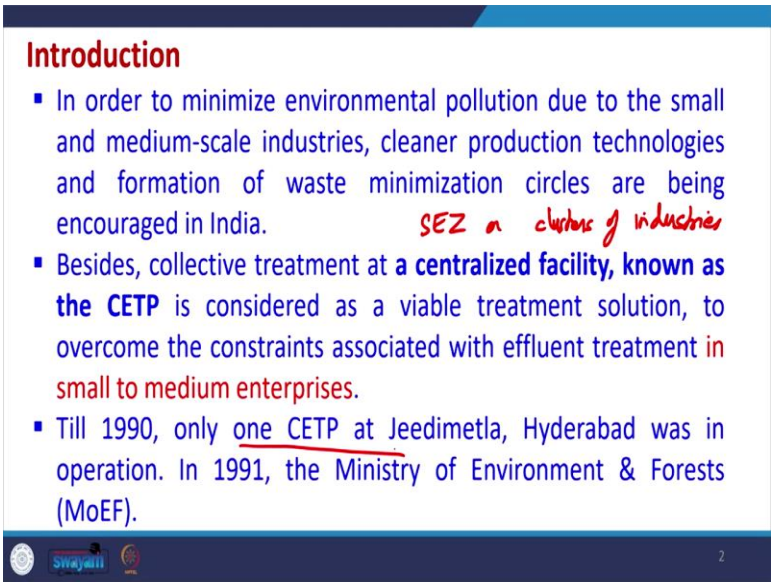
Physico-Chemical Processes for Wastewater Treatment
Professor V.C. Srivastava
Department of Chemical Engineering
Indian Institute of Technology, Roorkee
Lecture 59
Common Effluent Treatment plant (CETP)

Good day everyone and welcome to these lectures on Physico-Chemical Processes for wastewater treatment. So, in the last few lectures we studied regarding the case studies with respect to wastewater generation and their treatment in various industries. And we studied regarding these treatment strategies in sugar industry distilleries, fertilizer plants, and petroleum refining units.

Now, today we will be discussing the recently last 2 decades developed strategy and this particular thing is called as common effluent treatment plant. So, in this case, actually the effluents collected from different industries where some primary treatment may have been done earlier, that is further treated in a common effluent treatment plant. So, this is commonly cause as CETP. So, we will try to understand the CETP and how they are functioning, how they have evolved, and what are the advantages and constraints with respect to use of CETP.

Now, already the government of India is pushing and various with respect to minimization of environmental pollution, due to small and medium scale industries, that cleaner production technologies are being implemented, new type of waste minimization techniques are being implemented or encouraged. Besides all these techniques, there is a new collective wastewater treatment strategy, which is being now used across the country at various places where cluster of industries are there.

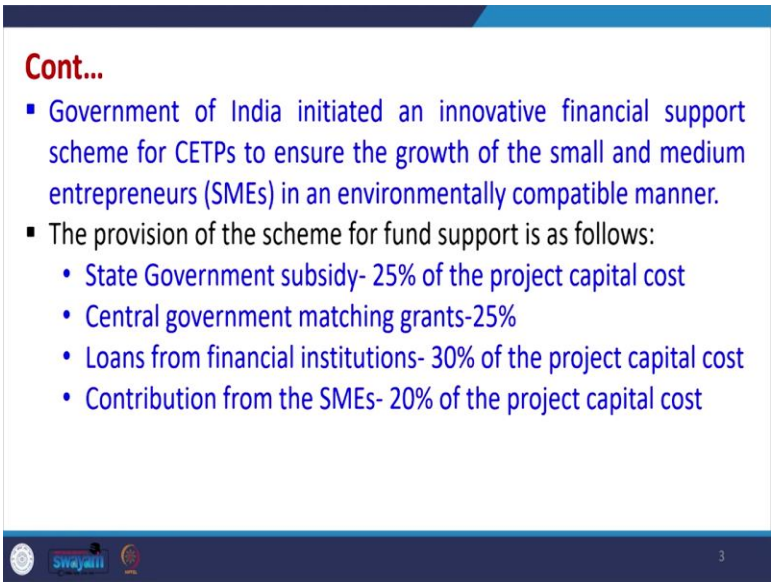
(Refer Slide Time: 02:22)



That means, wherever we have a special economic zone or wherever we have clusters of industries, so, at those places, the CETP is being made and the CETP which is a centralized facility, for that industrial cluster is being considered as a viable treatment solution. And actually, the use of CP helps in overcoming the constraints which may be associated with respect to effluent treatment in small and medium enterprises. So, it is there.

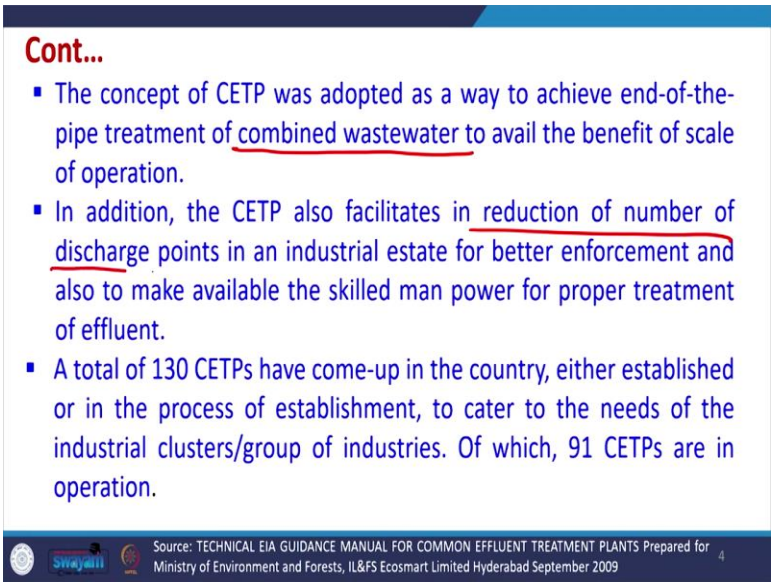
Till 1990, only one CETP was functional in Hyderabad after the Ministry of Environment forest or nowadays it is called as Ministry of Environment forests and climate change so that is a pushing for a lot of CETPs and using CETPs for effluent treatment, which are getting generated in these small and medium enterprises.

(Refer Slide Time: 03:15)



Now, the government of India initiated an initiative financial support scheme for CETPs to ensure the growth of small and medium entrepreneurs in an environmentally compatible manner. Now, the provisions of the scheme for fund support are given here as like state government will give subsidy 25 percent of the project capital costs central government will give the similar matching grant of 25 percent loan from financial institutions will be available also the SMEs the Small and Medium Entrepreneurs or enterprises, they have to give around 20 percent of the project capital cost, so, this is how the CETP are being implemented.

(Refer Slide Time: 04:26)



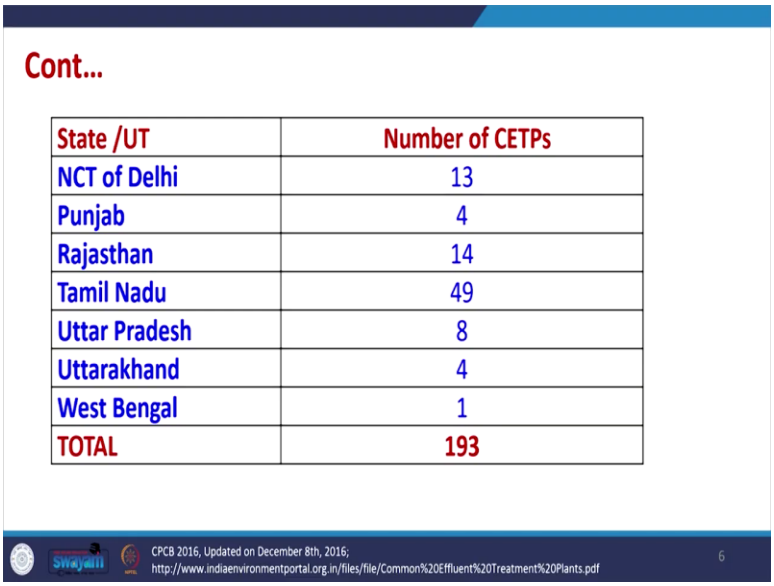
Now, the concept of CETP was adopted as a way to achieve end of pipe treatment of combined wastewater to avail the benefit of scale of operation because if individual industries actually start treating the water, so, they will require a lot of land space. Beyond that, they will require a lot of energy input and cost input.

So, that will cause problem to them because the amount of water generated in these industries may be smaller. Now, if we combine all the water, so, the amount of water will be high. So, the treatment… still the treatment can be done, but the cost thing will come down tremendously. So, to avail the benefit of this the concept of CETP has been adopted.

Now, in addition, a CETP also facilitates the reduction of number of discharge points in an industrial estate. So, if we have industrial cluster and each and every industry has its own discharge point, so it is difficult to manage enforce the various norms which have been made by the government and but if the CETP is there, so we have only one discharge point and that can be easily be monitored or enforce so, this is there.

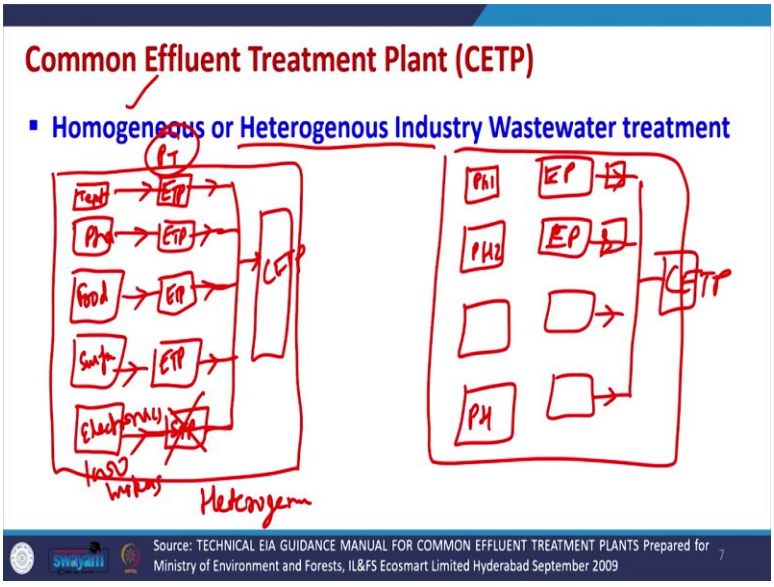
Because of this concept of CETP and its wider uses a large number of CETP have come up in the country and the number here it may be only already it may have changed a lot. So, it is continuously the number of CETPs in the country are increasing and a large number of CETP that is being made also.

(Refer Slide Time: 06:28)



Now, we can see here that a zone wise status of zone wise CETP is in the country is given here. So, all the all the states like Andhra Pradesh, Gujarat, Haryana, Maharashtra, they have large uncuff CETP. Similarly, Karnataka, Uttar Pradesh, Tamil Nadu all these are also having large number of CETPs and a large more number of CETPs are being built.

(Refer Slide Time: 06:36)



Now, there is the CETPs can treat homogeneous and heterogeneous industrial wastewater. So, how they are working let us try to understand. So, suppose we have a cluster of industry. So, we

are just marking it here. So, we have a cluster of industry it is possible that one of the industry may be textile another may be pharmaceutical, then there may be another industry may be there which may be producing some other type of chemicals may be food processing industry. Similarly, another industry may be there where other types of products may be formed including like surfactant, detergent etc.

So, these are different industries, Now, each of them is producing may have to adopt a different treatment strategy for treatment of their wastewater. Now, what is done is that, all these industries are told that they have to adopt some treatment strategy. So, this is called ETP or primary treatment strategies in each of the plant. So, each of the unit will be having some primary treatment we can call it as PT also primary treatment or many of the industries have to adopt more treatments. So, it may be up to ETP also.

So, this treatment has to be done after that the water which is generated, they do not go up to the standard they only perform primary treatment so that the characteristics of the effluent which are generated from all these industries, they are merged together and we have a larger CETP which is used and which actually treats the effluent. So, this is the strategy which is adopted.

So, we have only all these industries have to use primary treatment or it is also called as effluent treatment plant, but it will be having only minimum number of units only. So, only some basic units will be there like aeration unit, coagulation, flocculation etc depending upon the type of wastewater being generated, they may have some additional treatment also.

So, they will control the they will control the pollutant which is coming from that particular industry which is peculiar in nature like for the surfactant industry, their primary treatment unit or ETP unit will try to control the surfactant, from pharmaceutical they will try to see that antibiotics and other types of pharmaceutical drugs which are getting generated typically they may be removed beforehand. So, this is how that strategy works. Similarly, it is possible that a treatment plant may be there, industry may be there, which is like electronics industry. Now, this electronics industry is there.

So, we may think that why they will not require any treatment, but actually in actual condition, they may still be requiring some treatment of wastewater, wastewater is still will get generated

here because they may be having suppose 1000 workers in their industry. So, under that condition, they will be generating municipal type of wastewater, so, that wastewater is still has to be treated.

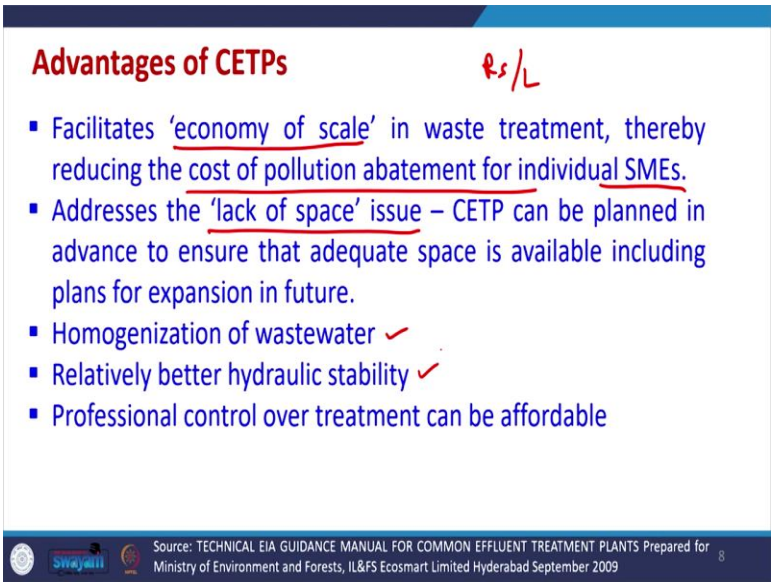
So, they may have to they may install some sewage treatment plant in place of effluent treatment plant is still they will have to install some plant or if their characteristic is not of that much bad quality so, it may be eliminated and water may directly go into and get mixed with this water and then it will go into the CETP where full treatment as per the discharge standard will be done. So, we have this cluster which is heterogeneous industrial cluster.

So, this will be heterogeneous industrial cluster which is there. Similarly, there is a possibility that in any industrial cluster only one type of industry is there. So, suppose all the industry are pharmaceutical, so, we have pharmaceutical 1 pH, pharmaceutical 2, so, all the industrial units are a pharmaceutical industries.

Similarly, there could be like I have seen myself that in one of the clusters only electroplating industries were there. So, all the industries were electroplating industry, so, I am writing just EP. So, all the industries are electroplating. So, under that condition, there may be thing that they do not require any treatment. So, all the water if they have the same characteristic, the water may directly go and get combined and get it may go into the CETP. So, this is possible, if their characteristics are different, some primary treatment is still may have to involve be used in some of the industries other industries may not use.

So, we may we have the possibility of homogeneous industrial wastewater treatment, so all the industries are homogeneous in nature all our pharmaceutical, all our electroplating all our textile unit only. So, depending upon that their wastewater will getting generated and it will go into the CETP. So, this is there.

(Refer Slide Time: 12:41)



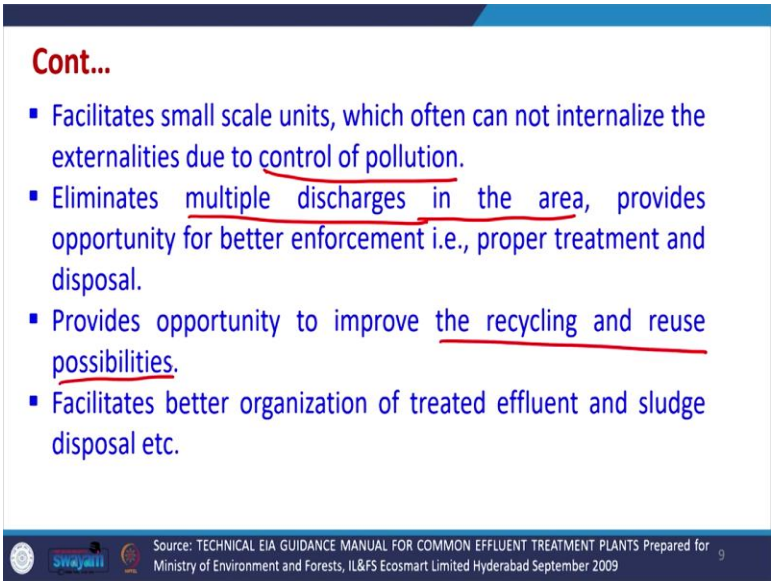
Now, understanding what are the advantages of CETP. So, advantages is that that it facilitate the economy of scale, because we are treating large amount of wastewater, the cost in terms of rupees per liter will go down very quickly treatment because we are only treating large amount of wastewater as compared to a small amount of wastewater.

So, the cost of pollution abatement will be much lesser as compared to if the treatment is being done in the individual SMEs. Now, also many small-scale industries, they cannot build the effluent treatment unit because their space is very less. So, they may be built in a very small space now, they do not have the space for building these treatment units so, the lack of space issue can be taken care of in the CETP scheme. So, this is there. So, CETP can be planned in advance to ensure that adequate space is available including plan of expansion also if possible in later on.

Now, it is also possible that the actual treatment plant homogenization of water is being done wastewater which is getting generated because all the wastewater is getting missed. So, we have a homogeneous wastewater which is coming. In this case we have to take care that some peculiar pollutant or nothing is coming out from these industries which is getting mixed with and other industrial wastewater and making the under industrial wastewater untreatable. So, that aspect is certainly there, but it still we are making the wastewater homogeneous in nature so, the treatment

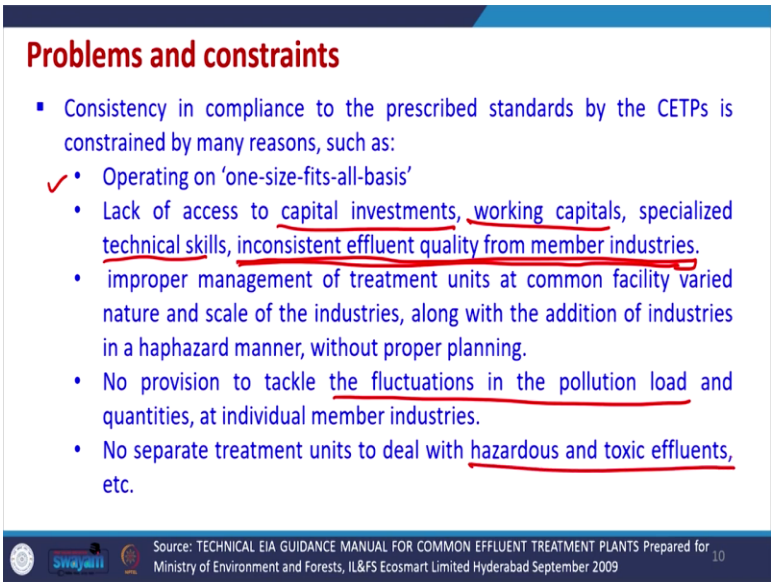
becomes easy. Now, relatively better hydraulic stability is also there, we can professionally control the treatment and it can become affordable also its so certainly.

(Refer Slide Time: 14:50)



Now, the concept of CETP facilitates small scale units which often cannot internalize the externalities due to control of pollution. So, all these SMEs become free in a way with respect to thinking of what is the pollution that they are doing. And so, these aspects they are free. Now, this eliminates multiple discharge point also in the area, because all the industries within that cluster are discharging the effluent only to be to the CETP where further treatment is done, it also provides opportunity to improve the recycling and reuse because the wastewater after that can be used in the whole industrial cluster for gardening, for irrigation etc, and also for reuse in the industry themselves. So, they can also take back the water, it also facilitates better organization of treated effluent and sludge disposal things in the CETP.

(Refer Slide Time: 17:12)



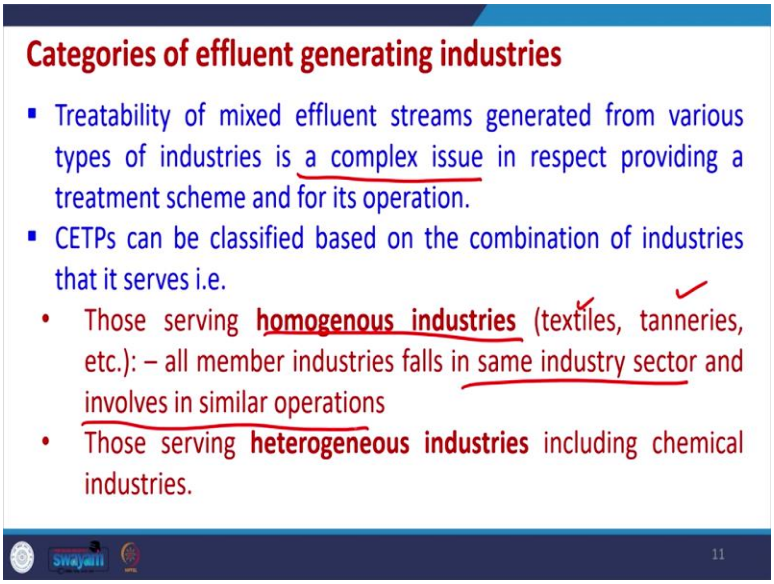
Now, what are the problems and constraints with respect to use of CETP. So, there are certainly advantages, but there are some problems and constraints also. Now, the consistency in compliance to the prescribed standards by the CETP is constrained by many reasons. Now, these CETPs, they are operating on one size fits all basis. So, that means they always expect the water to be some of homogeneous nature. Now, anytime if there is some problem in that industry and the ETP of that particular industry, which is generating some peculiar pollutant in not working well so, under that condition, the operation will be affected.

Also, since all the industries may be discharging different quantity of wastewater. So, if all are levied the same amount or the industry have to give the same amount to the CETP for the treatment of their wastewater, then they may cause operational issues. So, lack of access to the capital investments sometimes working capital specialized technical skills with respect which is required in the CETP and inconsistent effluent quality, this is the most important parameter because if any industry is not properly doing the pretreatment, in particular in a heterogeneous CETP, then there is a lot of problem may happen, the treatment thing can totally go off in the CETP.

Now, improper management of treatment unit at a common facility varies with the nature and scale up of the industries along now, if more number of industries are getting added in hazard manner, so, without any proper planning, then the CETP may not work properly. Also, no

provision to tackle the fluctuations in the pollution load, because this is very important the inconsistent effluent and the fluctuation in the pollution load and the quantity so, from the individual member industries, so, if any of these issues are there, then the problem will happen with respect to treatment in the CETP. Now, no separate (treated) treatment units to deal with the hazardous and toxic effluent which are generated in some of the industry. So, that may be also one of the problem and constant area.

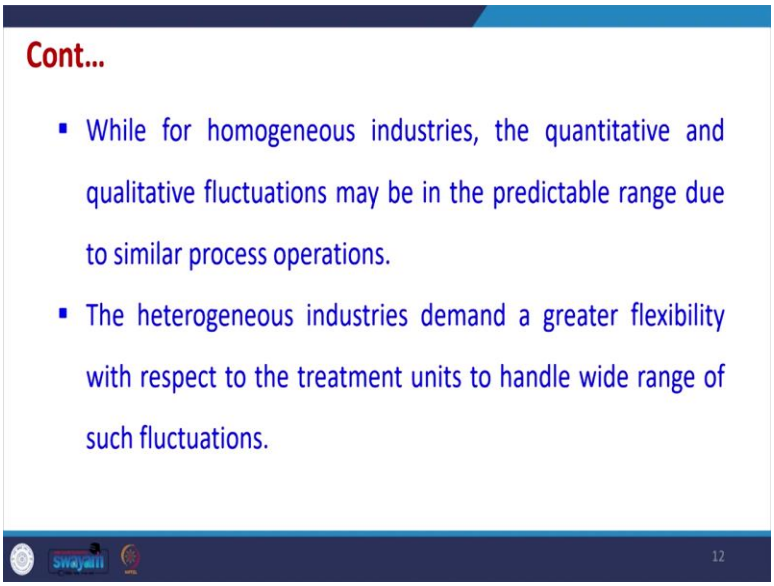
(Refer Slide Time: 18:52)



Categories of effluent generating industries already we have discussed. So, treatability of mixed effluent streams generated from various types of industries is a complex issue, it is not very, very easy with respect to providing a treatment scheme and for its operation. CETPs can be classified based upon combination of industry. So, homogeneous industries already we have discussed.

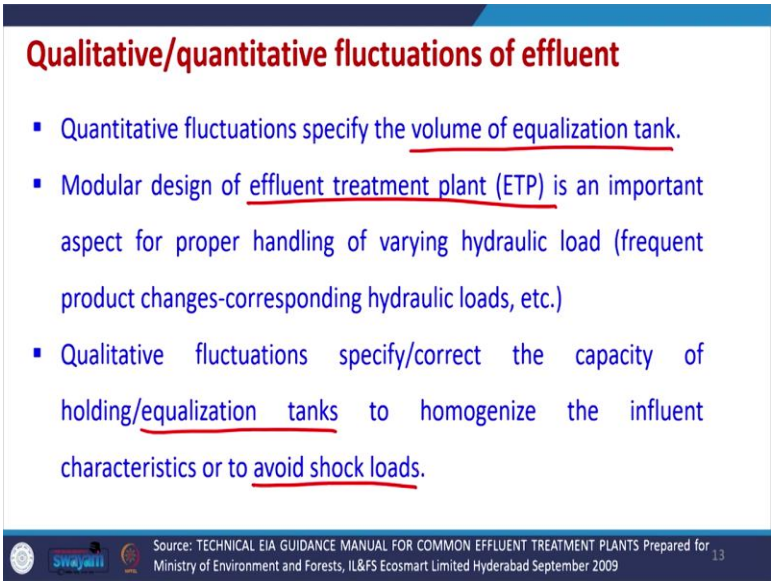
So, we may have a textile cluster maybe there, a tanneries cluster maybe there, electroplating cluster can be there so, this is homogeneous industries. So, all member industries fall in the same industrial sector and involve in the similar operation. In the homogeneous industry cluster they may be different industries which will be there. So, heterogeneous industries will be there.

(Refer Slide Time: 19:42)



Now, while for homogeneous industry the quantitative and qualitative fluctuations may be in within the predictable range, because their process operations are similar, but in the heterogeneous industry, there will be highly fluctuations may be high as compared to in the homogeneous industrial cluster. And because of that, there may be a lot of issues which may be there with respect to treatment of combined wastewater in the CETP.

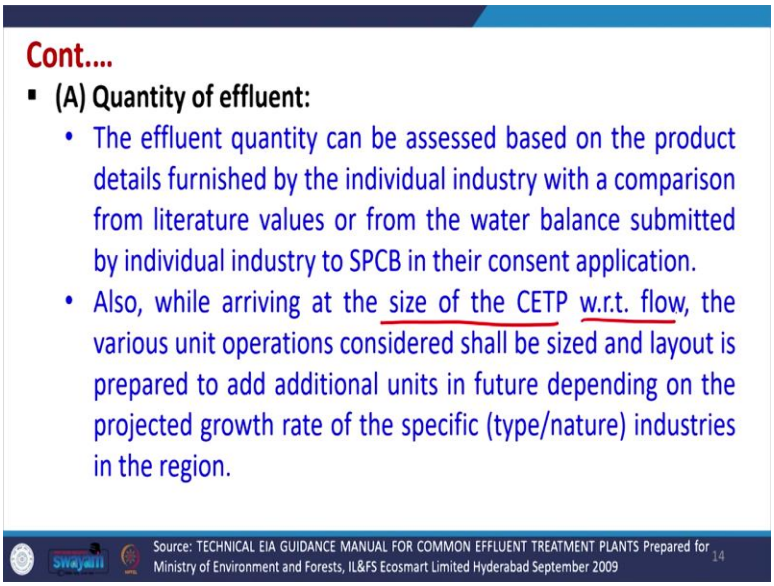
(Refer Slide Time: 20:41)



Now, the qualitative and quantitative fluctuations of effluent in particular with respect to heterogeneous industrial cluster, the quantitative fluctuations specify the volume of the equalization basin. So, that data is required. So, based upon that only, the equalization basin of the CETP can be designed. So, in this way we can properly operate the CETP. The modular design of effluent treatment plants is an important aspect of proper handling of varying hydraulic load, because these industries some of these industries may be seasonal in nature or they may be operating in a batch mode.

So, this way these industrial the volume may fluctuate a lot. So, that means the quantitative volume of water which is coming that will be varying a lot and we the CETP needs to take care of these fluctuations. Now, the capacity of equalization or holding tank must be properly determined to homogenize the influent characteristics and it will help in avoiding the shock loads that will be going into the CETP.

(Refer Slide Time: 21:37)

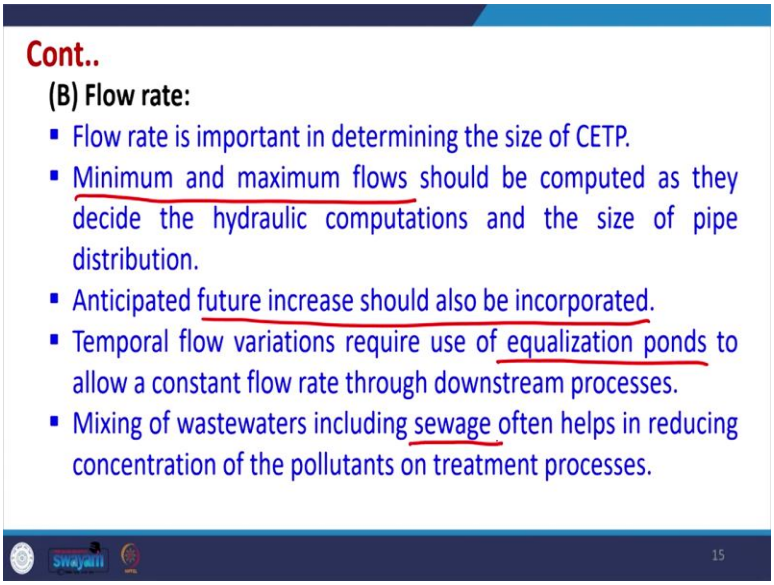


Then, the quantity of effluent, the effluent quantity can be assessed based upon the product details furnished by that individual industry with a comparison from literature values and from the water balance submitted by the individual industry to that particular state pollution control board or that particular industrial cluster organization. So, in their consent application, so, from that we can get to know that how much amount of effluent they are likely to generate. Also, with

respect to capacity, there is always with industries some idea is already always available that how much liter of water they can discharge at maximum.

So, from there also we can get to know that what will be the quantity of effluent that will be generated. Also, while arriving at the size of CETP with respect to flow, the various unit operations considered shall be sized and layout is prepared to add any additional units in future depending upon the projected growth rate of that industrial cluster. So, that is possible. So, with respect to flow, it is possible that during the initial design, the flow may be less, but it is it is being thought that with time, number of more industries are going to come and they will still discharge their flow into the CETP so that additional or future expansion should be properly take in care.

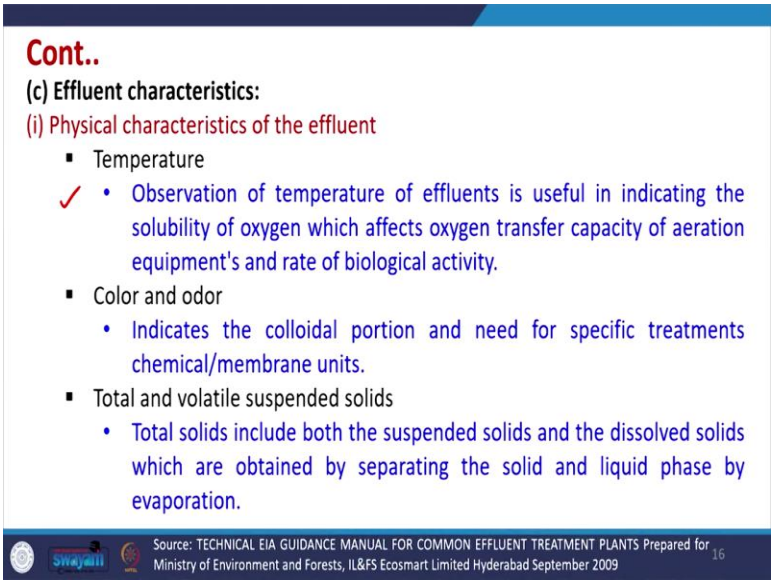
(Refer Slide Time: 23:14)



Now, with respect to flow rate, flow rate is important in determining the size of CETP, minimum and maximum flows should be computed as they decide the hydraulic computations as well as the size of pipe distribution. So, because the pipes channel etc are being used to take the wastewater from different industries to CETP. So, we should have a tentative idea of minimum and maximum flows, anticipated future increase should also be incorporated. The temporal flow variations that may be there they require a use of equalization ponds to allow a constant flow rate through the downstream processes.

So, we have lots of uses of equalization pond in CETP with respect to use of CETP in any industrial cluster. Now, mixing of wastewater includes sewage often, so, I have already told example, you suppose, any electronic industry is there. So, that may not generate a highly industrial wastewater it will generate sewage only. So, this also we have to see that mixing of wastewater including sewage often helps in reducing the concentration of pollutant, but we should have a tentative idea that how much flow rate of sewage will be there.

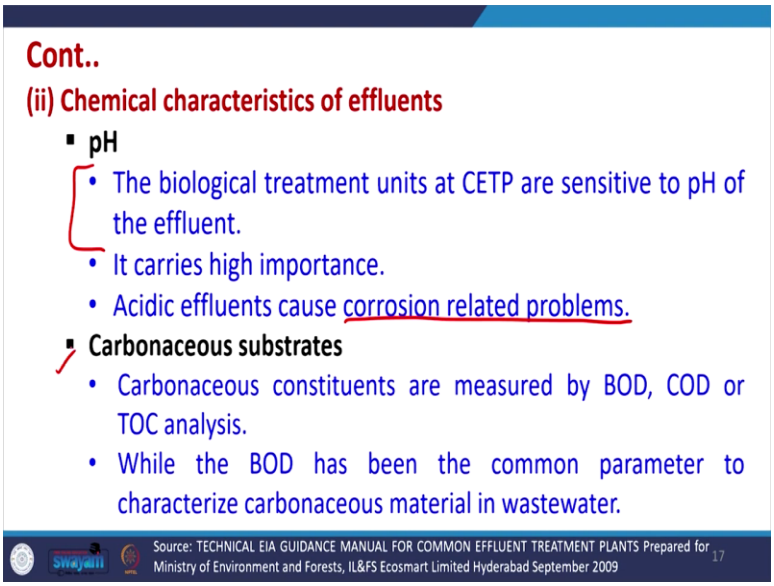
(Refer Slide Time: 25:00)



Now, in addition to flow rate, the quantity of water that will be generated the effluent characteristics is very very important. The physical characteristics of effluent in designing the CETP, which are very important include temperature. So, temperature of effluent is useful in indicating the solubility of oxygen which affects the oxygen transfer capacity in the aeration equipments. So, that is there.

Then color and odor, if any suppose any textile unit is there so, that will discharge lot of color, similarly, any other unit which is causing a lot of odor, so, that also we should know. So, if color and odor is there, it indicates the colloidal portion and needs a specific treatment or maybe in the that industry itself. So, that has to be seen. Similarly, total and volatile suspended solids. So, they may be including the both suspended and dissolved solids. So, their estimation is very important and based upon that the CETP has to be designed.

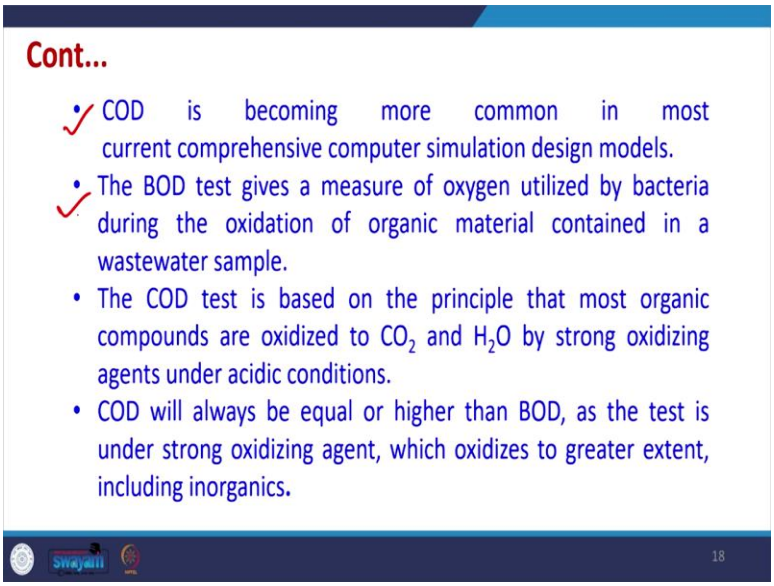
(Refer Slide Time: 27:00)



The chemical characteristics of the combined effluent or individual effluent the pH in particular the biological treatment units as CETP are highly sensitive to pH. So, if any industry is discharging some water wastewater with highly acidic condition or highly basic condition, we have to cross check that and we should be seeing that the water which is going for treatment in particular in the biological treatment units of CETP, it should have a highly homogeneous pH in the similar pH range, otherwise, it will totally damage that biological treatment unit.

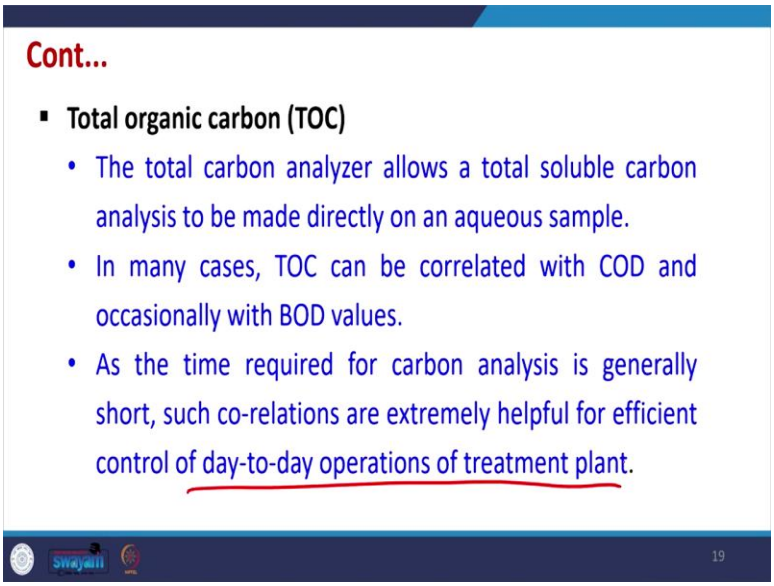
So, it is very very important that we should cross check and see. Acidic effluents may also cause corrosion related problems in the pipelines as well as in the CETP itself. Now, many effluents contain lot of carbonaceous substrates. So, carbonaceous constituents are measured by BOD, COD, TOC etc. So, these parameters already we have studied. So, this idea should be there that what is the load that is coming to the CETP.

(Refer Slide Time: 27:16)



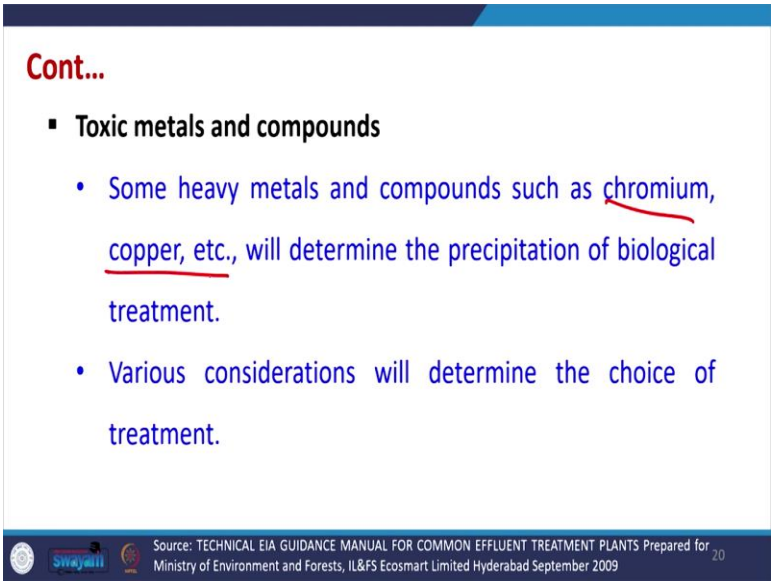
Now, COD is becoming more common parameter in most of the current design models. So, this COD is more used, but BOD gives us that idea that how much treatment is possible in the biological treatment units. So, if BOD and COD or their ratio is known, so, it gives idea that how much what should be the treatment strategy, whether we require tertiary treatment and how what different types of tertiary units will be required. So, that will be known from both BOD and COD value. COD value will always be higher than the BOD, this is well known. So, so, this COD estimation or BOD and COD is very important for design of CETP.

(Refer Slide Time: 28:08)



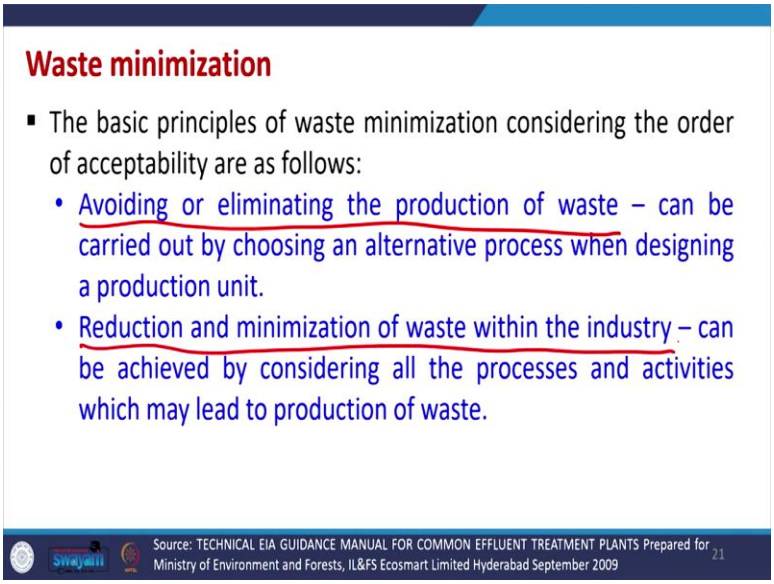
Similarly, TOC is another parameter which is nowadays being used in place of COD, but it gives a tentative idea that how much total organic carbon is present in the water. And through this analysis, we can know that we can control that day to day operations of the treatment plant itself. Now, this is easy to estimate, but we require a sophisticated instrument for measuring the TOC values.

(Refer Slide Time: 28:35)



Now, what types of toxic metals and other types of compounds are present in the combined effluent which is getting generated from these industries. So, if some heavy metals such as chromium, copper etc are present so, they will determine the precipitation of biological, they will determine that what will be the efficiency of biological treatment or how to remove these metals beforehand. So, various considerations may be there with respect to choice of treatment, if these toxic metals and or other compounds are present in the water. So, this is there.

(Refer Slide Time: 29:17)



Now, before CETP always it is better to minimize the waste in the industries itself. So, waste minimization strategies in the all these SMEs is very important. So, the basic principles of waste minimization considering the order of acceptability are as follows, avoiding or eliminating the production of waste. So, this this has to be done by the industry itself.

Nowadays, in many CETPs, they are charging the industries with respect to that, how much quantity of water they are giving and what are the characteristic of the water. So, if they are doing waste minimization, so, the CETP will charge less as compared to in the condition when they are not doing any waste minimization. Along with the quantity of water, the characteristic of water is also defined in different ranges.

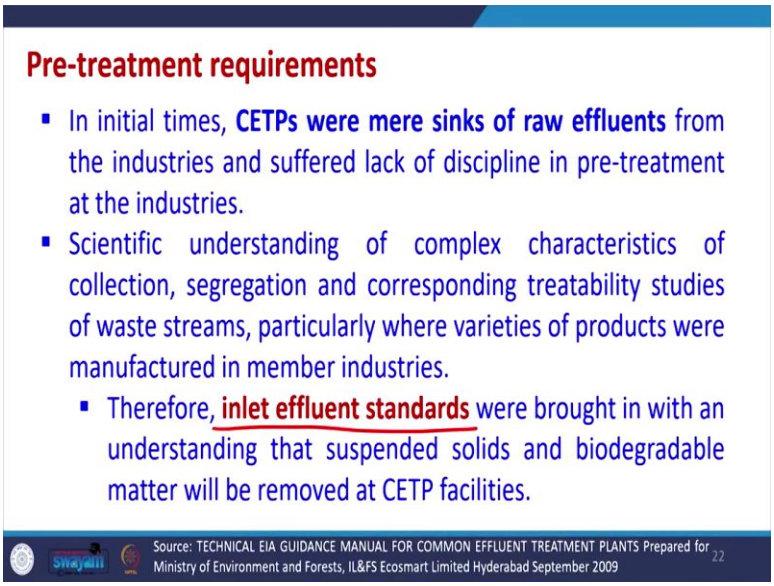
So, they are levied with respect to that rupees per unit COD rupees, per unit some particular key parameter. Now, if any industry is discharging some highly objectionable pollutant to CETP, the

amount of penalty levied on that industry may be higher. So, any parameter which affects the working of CETP, for that industry, the charges levied may be very high.

So, like suppose if we any industry is discharging some compounds or chemicals, which may hamper the operation of CETP so, that particular industry may be charged very heavily. The examples could be surfactant or very low pH, wastewater or very high pH, wastewater or any other parameter as well.

So, it is very important that these industries should minimize the waste by themselves. The reduction and minimization of waste within the industry is very very important, it helps the industry also and it helps the CETP also with respect to its operation. Now, in each of the industry, some pretreatment may be required.

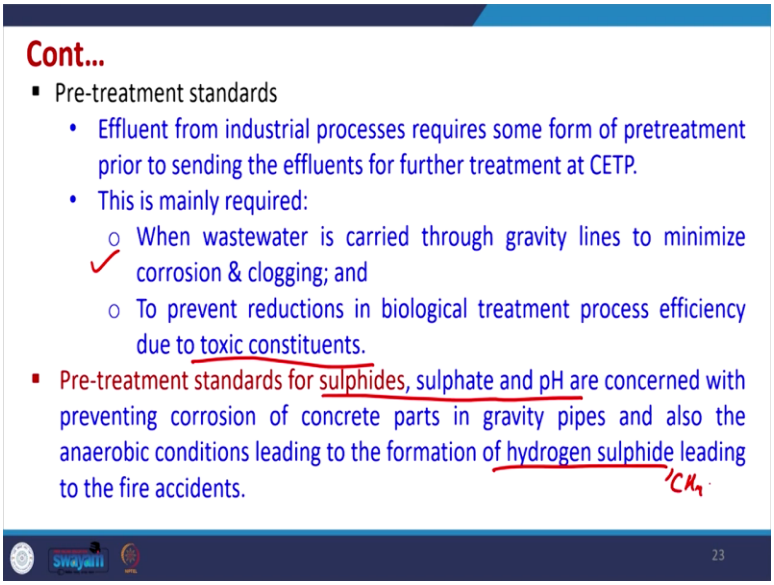
(Refer Slide Time: 31:43)



So, in the initial times, the CETPs were considered to be the sinks of all the raw effluent from the industries and because of that, they suffered a lot of problems and they did not know that what pretreatment is strategies have to be followed at the industrial level or at the CETP level. Now, in many industries, the industry themselves have to do the pretreatment, the scientific understanding of complex characteristics of the wastewater generated in different industries have helped in understanding that what type of key pollutants need to be removed beforehand.

So, this way the pretreatment has to be done. So, the inlet effluent standards have been set for many CETPs. So, they will be taking effluent with some particular characteristics, and if the variation is way beyond that, the amount of charge which will be there for that particular industry will also vary. So, this inlet effluent standards were brought in, with an understanding that suspended solids biodegradable material will be removed that CETP but other types of things have to be removed before hand any peculiar compound or chemical have to be removed beforehand in the industry itself.

(Refer Slide Time: 33:18)

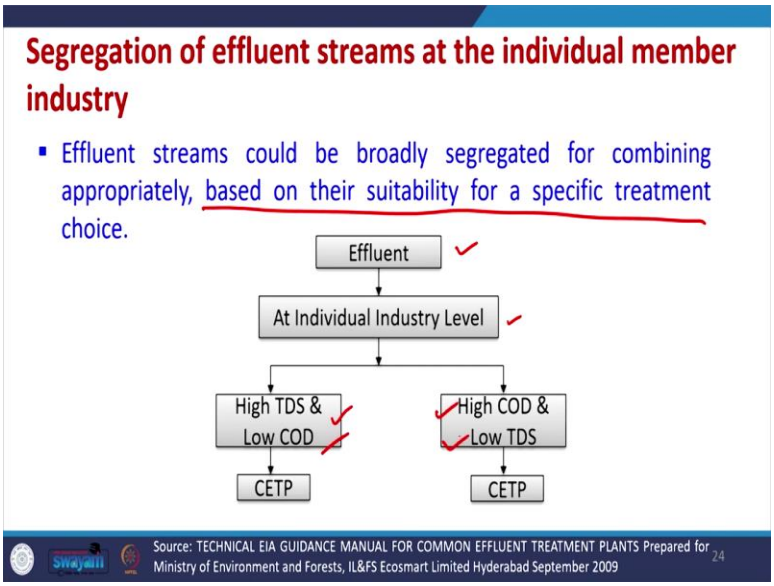


Now, the pretreatment industries effluents from industrial processes require some form of pretreatment prior to sending the effluent for further treatment at CETP. This may it is mainly required when wastewater is carried through gravity lines to minimize the corrosion and clogging to prevent the reduction in biological treatment process efficiency due to many any toxic constituents or otherwise.

So, that is why the pretreatment has to be done in the industry itself. Now, the pretreatment standard for sulphide, sulphates, pH they are now highly objectionable and they have to be treated beforehand. So, either they have to be treated in the industry or some industries may can mix up them together before sending them to the CETPs but this treatment has to be done beforehand. So, this is there.

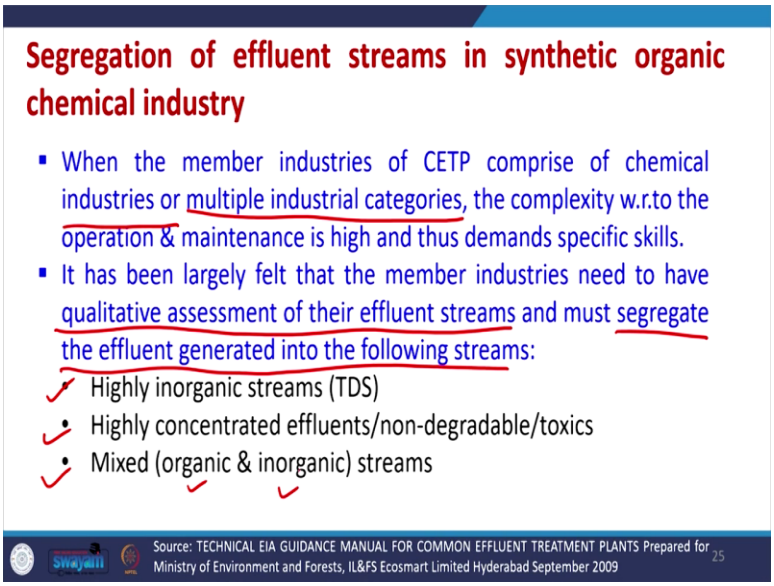
Similarly, in the pipeline, there maybe also formation of anaerobic condition maybe there prevailing. So, it may lead to formation of hydrogen sulphide that may lead to the fire accidents hydrogen sulphide methane etc may get form. So, all these aspects have to be taken care in the pretreatment itself.

(Refer Slide Time: 34:38)



Now, before sending the effluent to the CETP, segregation of effluent streams at the individual member industry is also very important. So, effluent streams could be broadly segregated by combining appropriate based upon their suitability for a specific treatment. So, effluent at individual industry levels they may be classified into different high TDS, low COD or high COD low TDS. So, the treatment strategies could be different in the CETP for such wastewater. So, segregation is very important.

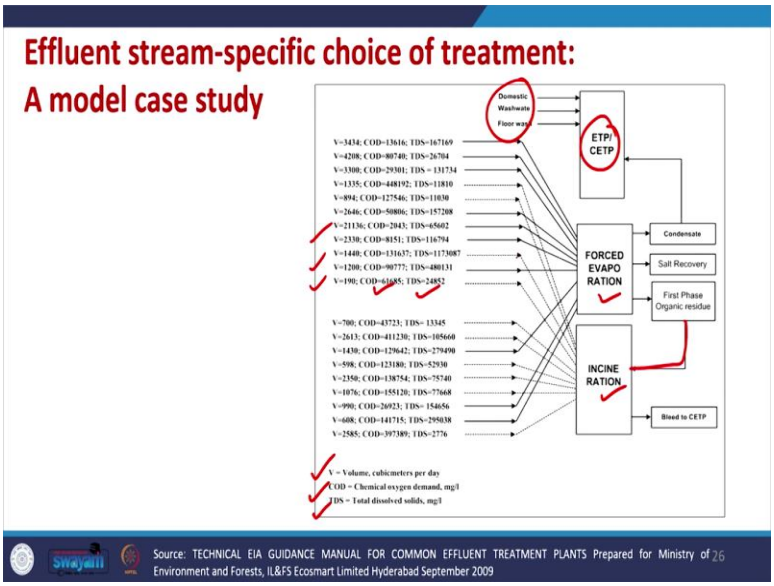
(Refer Slide Time: 35:20)



Now, in organic chemical industry similarly, there may be different types of wastewater, so, which may get generated. So, the when the member industry as of CETP comprise of chemical industries or multiple industrial categories that complexities with respect to the operation and maintenance is very high in the CETP and they demand very high specific skills.

So, it has been felt that the need to have some qualitative assessment of their effluent stream so, all the industries, member industries need to perform this qualitative assessment and they must segregate the effluent generated into the streams which are like high inorganic streams, highly concentrated effluent or non-degradable or toxic effluent, no- degradable compounds containing effluent similarly, it may be mixed which where both organic and inorganic streams are there. So, this type of clustering segregation of different effluent stream is highly important before sending them to the CETP.

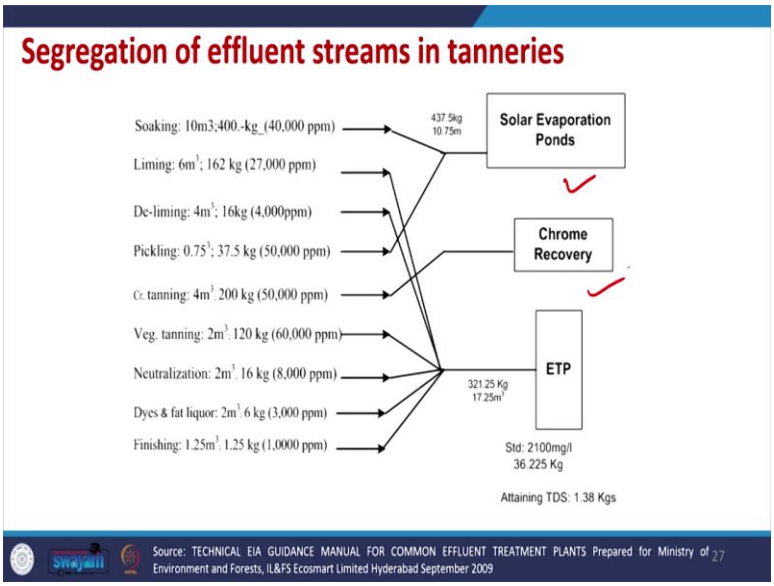
(Refer Slide Time: 36:33)



Now, these are some of the ideas with respect to depending upon that what amount of water what amount of COD or TDS is there. So, we may use different types of units. So, some may be having the treatment has to be done in the ETP as some this will be the last step. So, domestic wastewater at sector may go directly depending upon the volume, the COD and TDS.

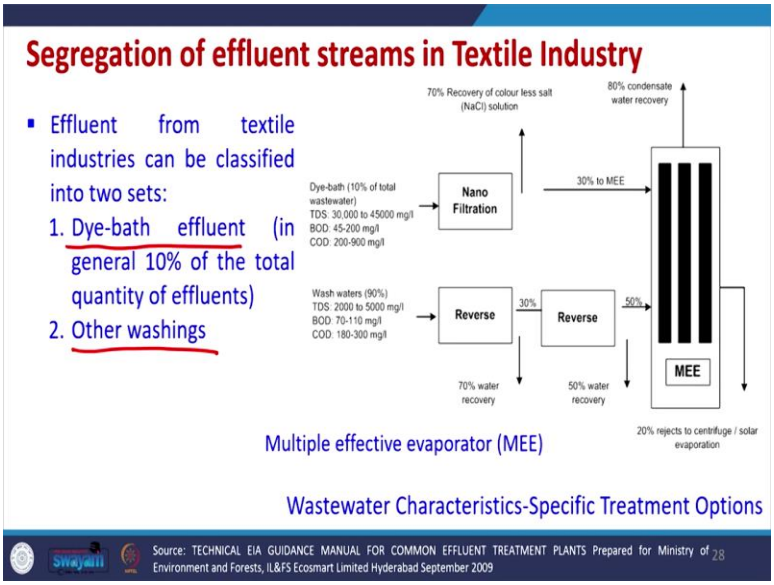
So, before sending the water to CETP etc some forced evaporation or incineration may have to be done later on depending upon this. So, we can see depending upon COD depending upon volume depending upon TDS so, any treatment may have to be done beforehand after and so, segregation has to be done before properly using the CETP.

(Refer Slide Time: 37:30)



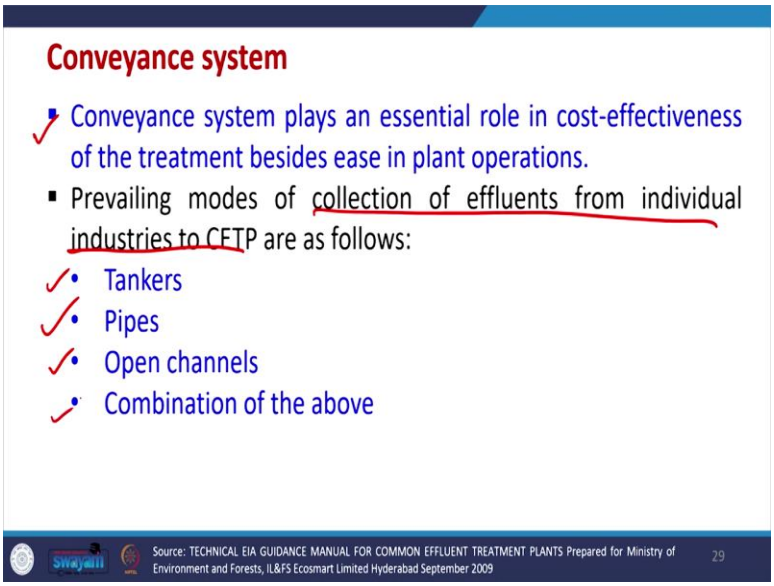
Similarly, for tanneries we have may have different choices like Solar evaporation ponds, Chrome recovery, some ETP beforehand before sending to the CETP.

(Refer Slide Time: 37:43)



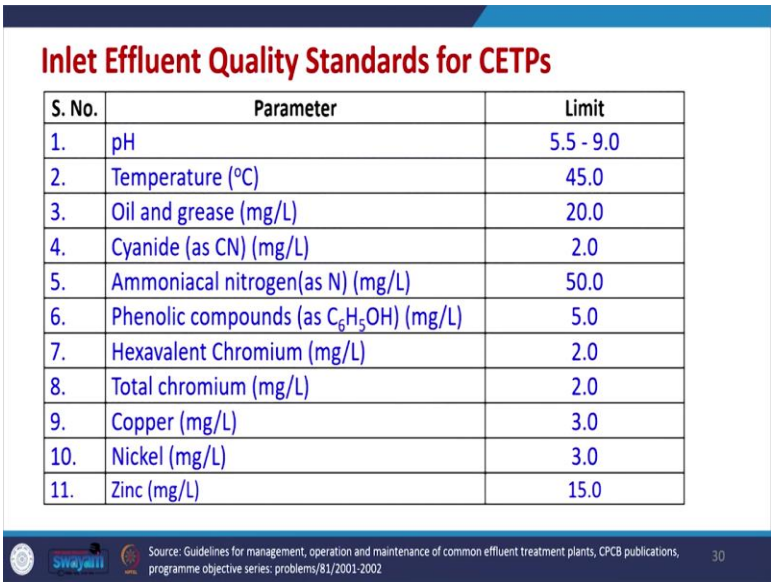
Similarly, for textile industry a lot of possibilities are there in particular because the textile industries maybe some industries may be generating dye-bath effluent only other may be generating only washings. So, depending upon the requirement, they may have different treatment strategies and then the further treatment in the CETP. So, this is there.

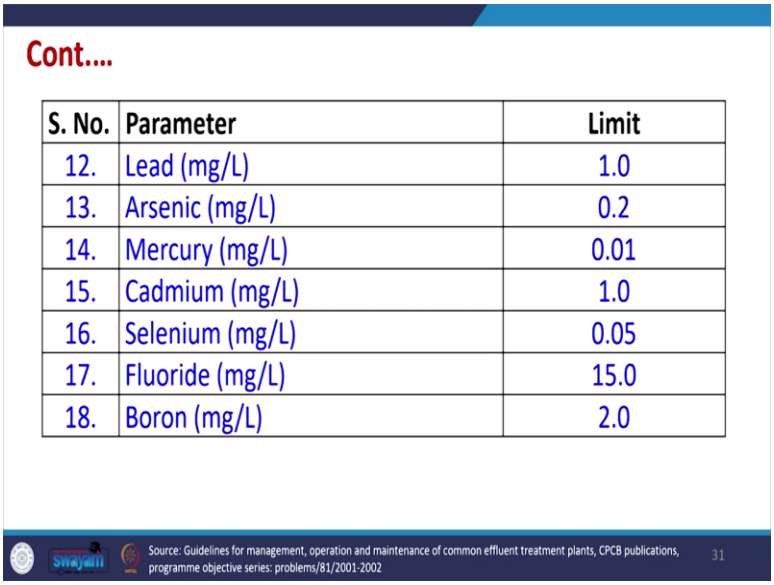
(Refer Slide Time: 38:10)



Now, once the wastewater has been generated in different industries. So, it has to be taken to the CETP. So, the convenience system (with it) which is there that plays an essential role in cost effectiveness of the treatment besides the ease in plant operation. Now, during this the modes of collection of effluent from individual industries to CETP generally it will be preferred to have pipes, open channels, tankers are less preferred, but if the gravity flow cannot happen or if the pipes and channels have not been laid, then the tankers can be used or we can have a combination of any of them for conveying the water from individual industry to the CETP for further treatment.

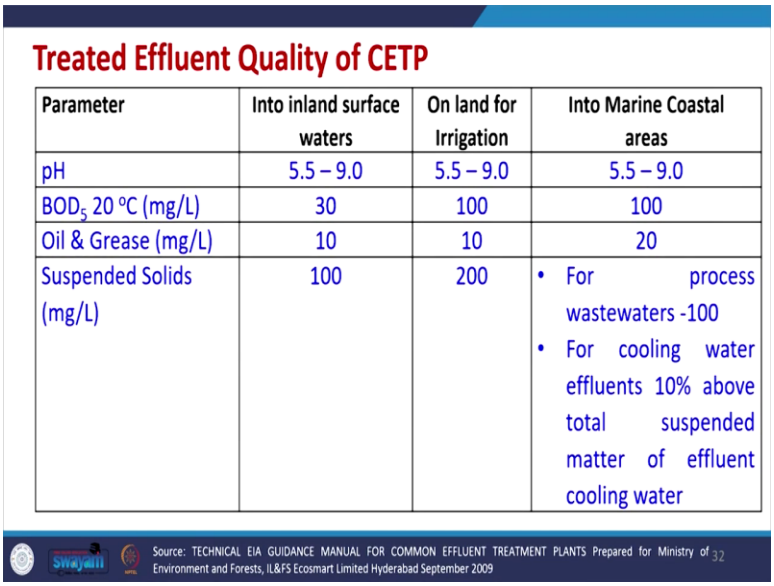
(Refer Slide Time: 38:55)

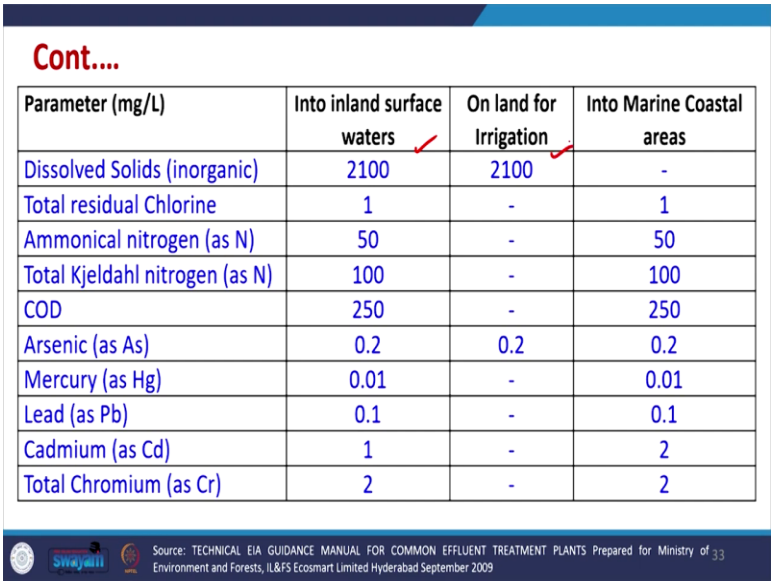




Now, in the CETP, the inlet effluent quality standards may vary. So, these are the different standards which have been set it may vary from CETP to CETP whether it is heterogeneous or homogeneous.

(Refer Slide Time: 39:13)





Then similarly, after treatment that treated effluent quality from the CETP should always comply to the norms set by the government of India. So, this is this has to be met and whether the discharge from CETP is going for inland surface water or for online for irrigation or into Marine Coastal areas that will depend generally from industrial clusters they may not be allowed to discharge any wastewater also. So, they have to recycle and re use the water itself, but these are the some of the standards so which have been set.

(Refer Slide Time: 39:52)

So, some of the references which have been used in the present slides are given here, we will in the next lecture, what we will do is that we will try to understand that what are the different strategies which are possible with respect to treatment in the CETP. Also, we will compare the different treatment strategies with respect to their application for treatment of various types of wastewater, that we will try to summarize in the next lecture, which is the last lecture of this series of lectures with respect to treatment of physico-chemical treatment of wastewater. Thank you very much.