Water and Wastewater Engineering
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Industrial Wastewater Treatment
Lecture # 36

In the last few classes we were discussing about advanced wastewater treatment and we also started discussing about industrial wastewater treatment. We have also seen what all are the major sources of industrial wastewater. They are originating from either the extraction or transportation of raw renewable resources and second one is the wastewater or the waste generated from the production itself and third source is when we use the products that itself can produce some waste and fourth one is ultimate discard of the products.

For example, if you take the case of a pesticide the production itself will be generating so much of waste. The reason is it will be involved in so many chemical processes and many separation processes.

Now, coming to the product use we know that pesticides are sprayed to the plants and other places so what will happen is a portion of that one will be entered into the atmosphere and something will be getting adsorbed on the plants and a part will be going to the soil and ultimately this one will be coming to the surface and ground water sources. Moreover, it will be getting accumulated in the plant itself and when we consume it will be entering in our body. And the last one is when we discard the used products for example the pesticide bottles definitely when we throw it away some pesticide will be there in the bottle so that also be creating environmental pollution or environmental degradation. These are the major sources of industrial pollution and at each and every stage it will be creating so much of problems.

We also discussed about the nature or the types of pollutants present in industries those include inorganic salts, acids and alkalis, organic matter, suspended solids, floating solids and liquids, heated water, color, toxic chemicals, microorganisms and foam producing matter. These components present in the wastewater will be depending upon the process and the product because for each product the raw material required is entirely different.

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We also discussed about what is the difference between the industrial and municipal waste or when we discuss about the wastewater treatment what is the difference between industrial wastewater treatment and municipal wastewater treatment. In municipality wastewater treatment is taken as a public service because public will be generating the domestic waste and that institutes the responsibility to treat the waste and protect the environment.

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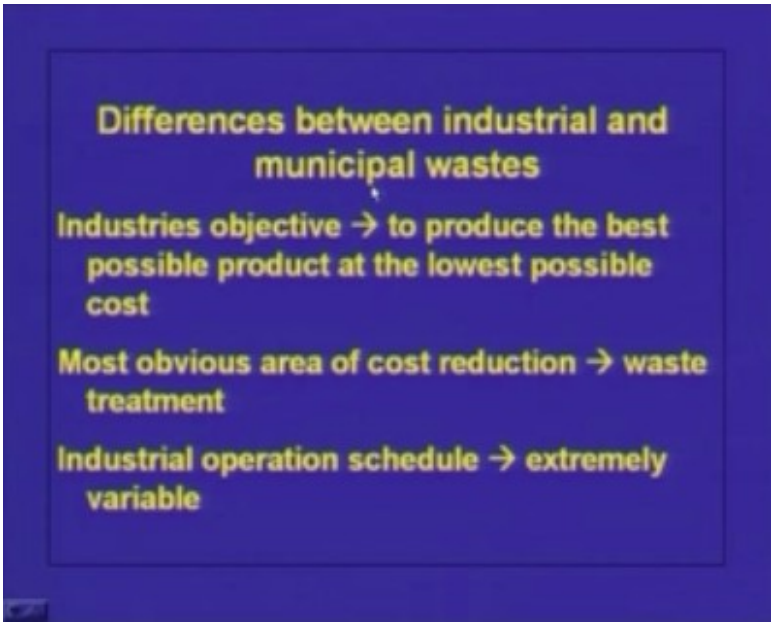

But when it comes to the industry what is happening the major objective of the industry is to reduce the cost of production because they have to survive in the market so if the same quality of the product if they can supply at a lower cost that will be much more beneficial for the industry so wastewater treatment or the waste treatment that cost involved is not at all going to improve the product's quality. So, if they wanted to cut down the product cost one way is to cut down the waste treatment cost so they will be seeing the waste treatment as imposed criteria on them because through the waste treatment they are not going to achieve much.

Now the concept is entirely changing because the industry itself is realizing that the waste whatever they can treat or use that is the resource conservation because waste is nothing but the resource out of its place. Now we will see what all are the different theories which we can apply for the industrial wastewater treatment.

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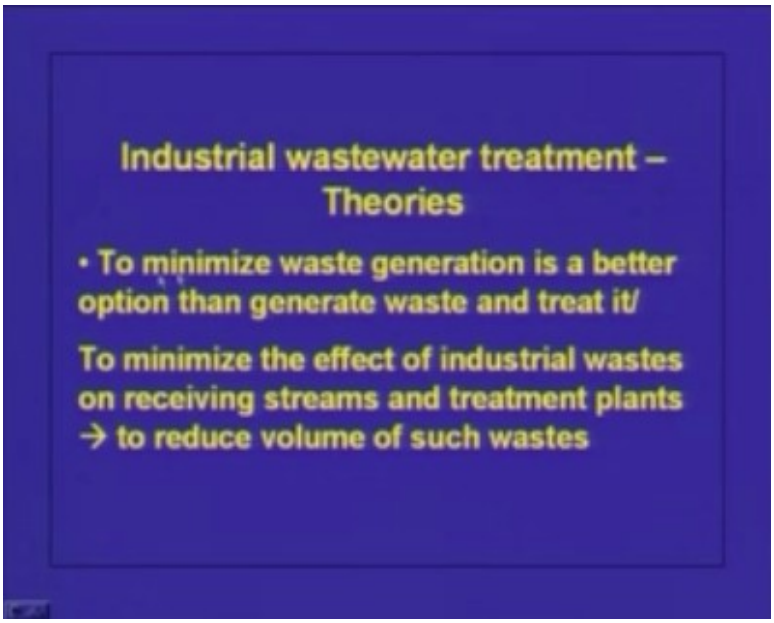

The first one is it is always advisable to minimize the waste generation instead of generate the waste and treat it. because once you generate the waste resources whatever is present either in the raw material form or the product form it is going out of the place and that itself will be causing some economic loss and again if you want to treat the wastewater or the solid waste to meet the standards definitely the treatment will be incurring some cause so it is always advisable to minimize the waste generation than generate waste and treat it.

Second one is to minimize the effect of industrial wastes on receiving streams and treatment plants. We know that it is impossible to reduce the wastes to almost zero so there will be some waste generated in the industries so it is always better to reduce the volume of waste so that the effect of wastes on the environment or the receiving streams will be minimum.

First we will see how the industry can reduce the volume of waste. There are different methods by which the volume of waste generated in the industry can be reduced.

- classification of wastes
- conservation of wastewater
- changing production to decreasing wastes
- reuse both industrial and municipal wastes and
- elimination of batch and slug discharges

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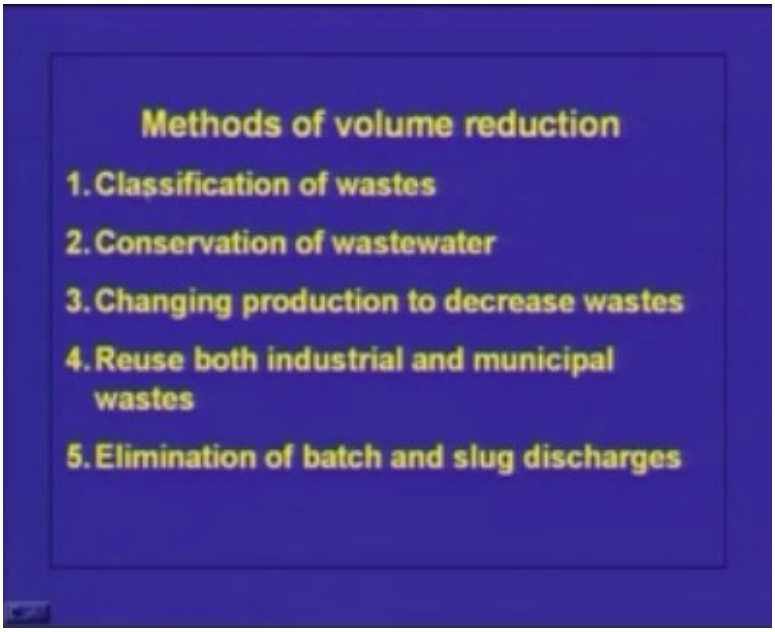

Now we will discuss each one in detail. First one is classification of wastes.
Waste classification is nothing but segregation of manufacturing process wastes from cooling water. That is the major one taking place because we know that in industry various processes are taking place so the water will be used as processed water, product water, cleaning water, cooling water etc. So naturally from the point of view of wastewater management the waste whatever is coming out of the processed plants or after the product recovery that waste will be containing maximum concentration and maximum number of pollutants but the waste whatever is coming out after washing the raw materials or washing the floors or the wastewater coming out of the cooling plant those wastewater will not be having much problems because the concentration of the pollutant will be very less. So, if you mix all the wastes together or in the industry all the waste is coming together and we are collecting them together then what will happen is you will be getting a large volume of waste with lot of pollutants so naturally what will happen is the treatment cost will be very very high. But if you can segregate the waste for example you segregate the waste from manufacturing process from waters used as cooling agents in industrial processes and waste from sanitary use we can reduce the

volume of the waste considerably. The reason is the water used for cooling will not be containing much of the pollutants so this water can be reused for many different purposes. So the total waste whatever is coming for the treatment will be reduced.

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Similarly the waste from sanitary use, we know what is the characteristics of sanitary wastewater. So, if you can segregate this one by giving a lesser extent of treatment we can reuse it for gardening and other purposes. So it is always advisable to classify the wastes so that will be reducing the volume of the waste that will be reducing the cost of the wastewater treatment. This is a very very important point as far as the industrial wastewater treatment is concerned, the segregation of waste or segregation of the process and depending upon the wastewater characteristics and its extent of pollution we classify the waste accordingly.

Second one is conservation of water. Whenever we talk about industrial pollution water conserved is water saved. The thing is it will be saving the wastewater treatment cost as well as the water charges so how can we do the conservation in an industry. Conservation begins when the industry changes from an open to a closed system. So, what most of the industries do is that if the water is available in plenty the water used for once will be just discharged out so naturally volume of the wastewater coming out of the industrial process will be very very high and naturally the treatment cost will be high. But if the industry can segregate the wastewater and reuse a portion of that wastewater for other purposes then definitely the volume of the waste generated can be reduced.

Some of the examples I have given here. One example is recycling of the white water in a paper mill.

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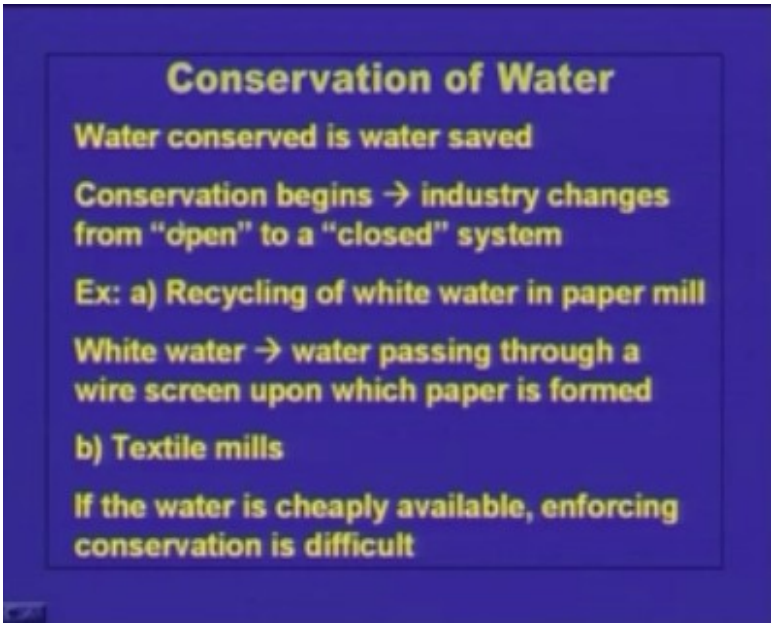

What is this white water? It is nothing but the water passing through a wire screen upon which paper is formed. This water will not be having much of the pollutants so the industry can reuse this water much easily. Similarly the cooling water, the only pollutant coming out of the cooling water is the high temperature and another one is because of the high temperature what will happen some evaporation losses will be there so the concentration of the solids will be getting increased because of the evaporation that is the only pollution present in cooling water. So, if you can dissipate the heat energy then we can recycle the cooling water so many times. The only thing is whatever is the evaporation loss if we can make it up with fresh water the solid concentration will not be increasing drastically and it will not be causing any problem for the heat exchanges.

Now coming to the textile mills it is shown that if the water availability is not there if water is available cheaply then enforcing conservation is difficult and in textile mills it is shown that whenever there was a water scarcity the total use of water has come down to fifty percentage. That means if they do the process properly whatever the effluent coming down that itself can be reduced to almost fifty percentage. But this conservation is very very difficult if the water is available cheaply because people will not be thinking about the reuse of the water at all.

Now the third one is changing the production to decrease waste. By changing the process itself we can decrease the waste. This is an effective method but it is difficult to put in practice because everybody resists change. So how can we do this one?

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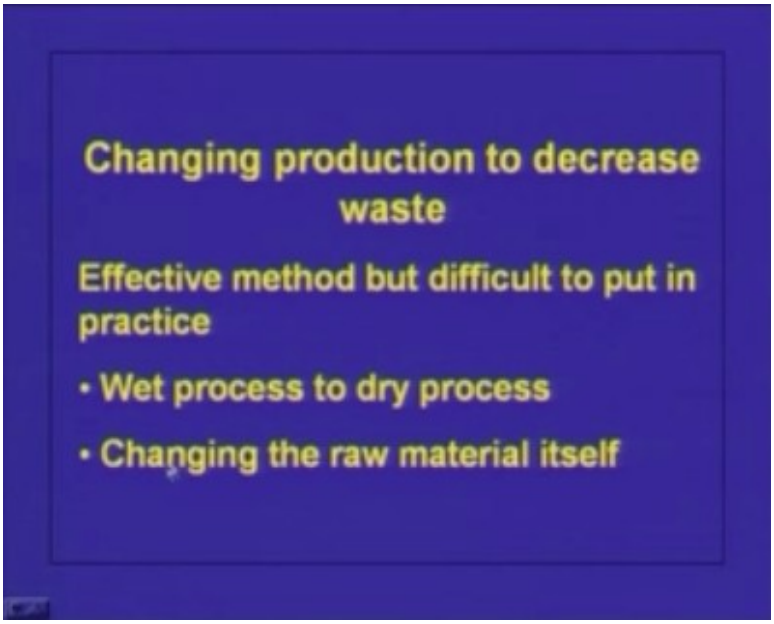

For example, if you have a wet process existing in your industry so if you change from the wet process to a dry process definitely the water consumption will be less and the waste generated will be also less. Then another one is changing the raw materials itself. Some raw materials require lot of water so if we can replace such raw materials with some other raw materials then also we can reduce the water consumption very easily. But as I have already mentioned this is very difficult to practice in industries because always the change is difficult unless they think by themselves. So, if we change this one it is going to bring us so much of profit otherwise it is very very difficult to implement the change in an existing industry. The other option is reusing both industrial and municipal effluents for raw water supplies. As I have already mentioned it is applicable only where water scarcity is existing.

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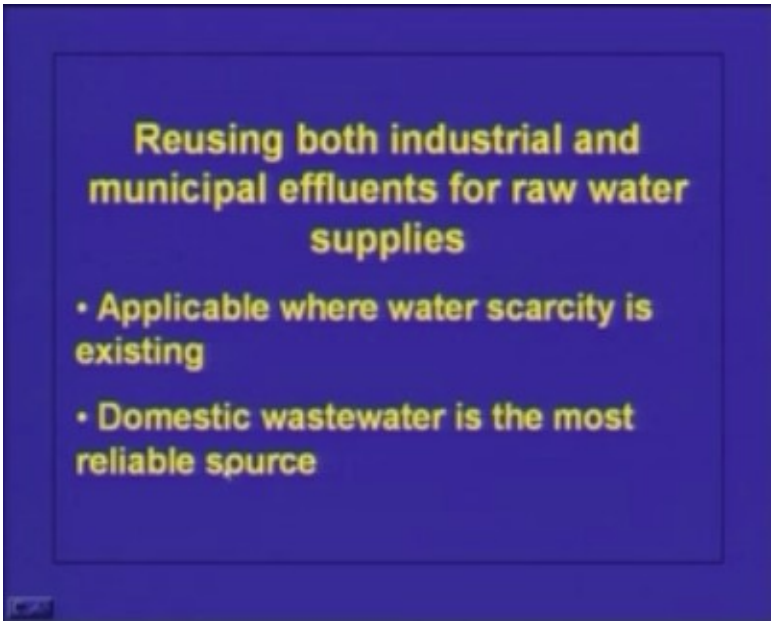

For domestic wastewater reuse is the most reliable source because we know that the industrial processes will be varying day by day. Because depending upon the production cycle or production pattern the quantity and the quality of the wastewater that will be coming will be varying. So if you want to reuse the industrial wastewater the processed wastewater as such the source may not be reliable. But in most of the industries what is happening they will be having their own estate where all the employees are staying so if you want to reuse the water it is always advisable to reuse the domestic wastewater because we know that the quantity of that wastewater will be remaining almost a constant and we know what is the fluctuations and variations happening and moreover characteristics of the wastewater is also well known and it is not going to change drastically. So it is always better to rely on the domestic wastewater source for recycling purpose. Many industries hesitate to reuse the wastewater. The reasons are as follows:

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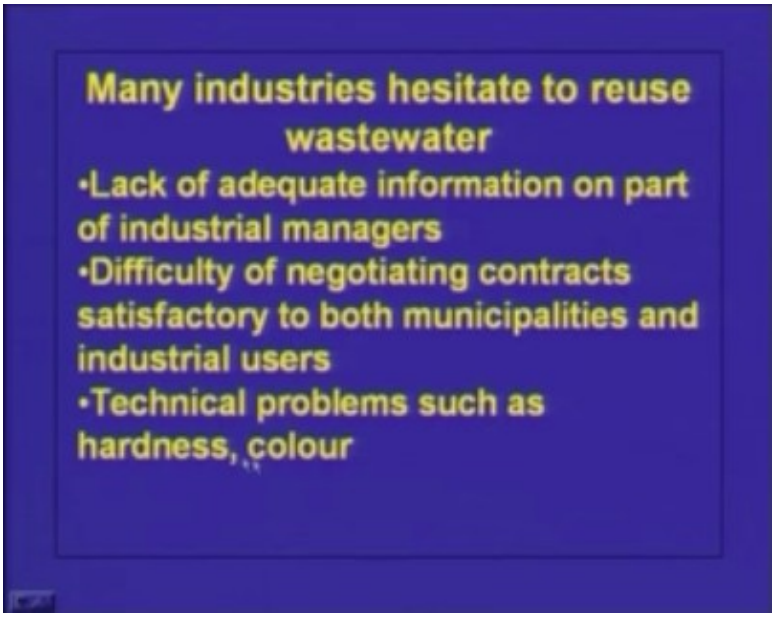

First one is the lack of adequate information on part of industrial managers because they won't be having enough information. What are the advantages they are going to get if they can reuse the wastewater so it is one major problem. Second one is difficulty of negotiating contracts satisfactory to both municipalities and industrial users. In many places the municipalities are doing water treatment, they are putting so much effort and money to treat the municipal wastewater or municipal sewage and they usually supply this treated wastewater to the industries. But in most of the cases what is happening is it is difficult to come on satisfactory contracts with the municipality and the industry that is another problem.

The third one is technical problems such as hardness; color etc because if you reuse the water it will be having many pollutants that will adversely affect the industrial processes. This is another problem.

Another issue is aesthetic reluctance to accept effluents as a potential source of water for any purpose because after treatment also we will be having some color, some odor etc so people will have some reluctance to reuse the water.

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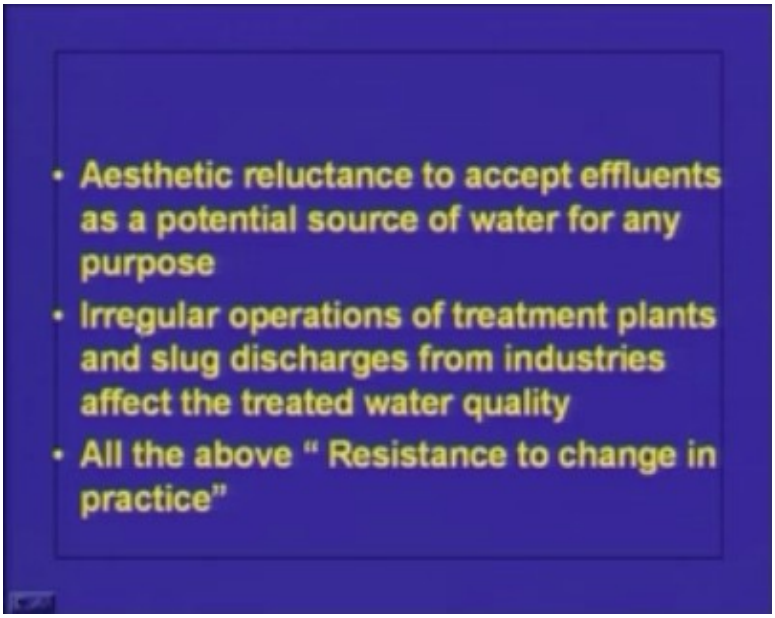

Another thing is irregular operations of treatment plants and slug discharges from industries affect the treated water quality. We know that the quality of wastewater whatever is coming out of the industries is not a constant one and we are designing our treatment plants based upon the average characteristics and average flow of the wastewater. So what will happen is if the industry is not operating uniformly or if the wastewater characteristics and the quantity varies drastically the treatment plants will not be achieving the desired treatment efficiency so definitely the treated water whatever is coming out will not be satisfying the requirements for the purpose of reuse, that is another problem.

But all the above the resistance to change in practice is the most severe problem because they are using fresh water so if there should be some changes in the process and the industrial layout or industrial process itself that requires some changes or resistance to change in practice is the most important problem or the biggest problem. As we are telling we can reuse the treated water what is the difference between sewage plant effluent and fresh water. Definitely the industries are bothered about this one.

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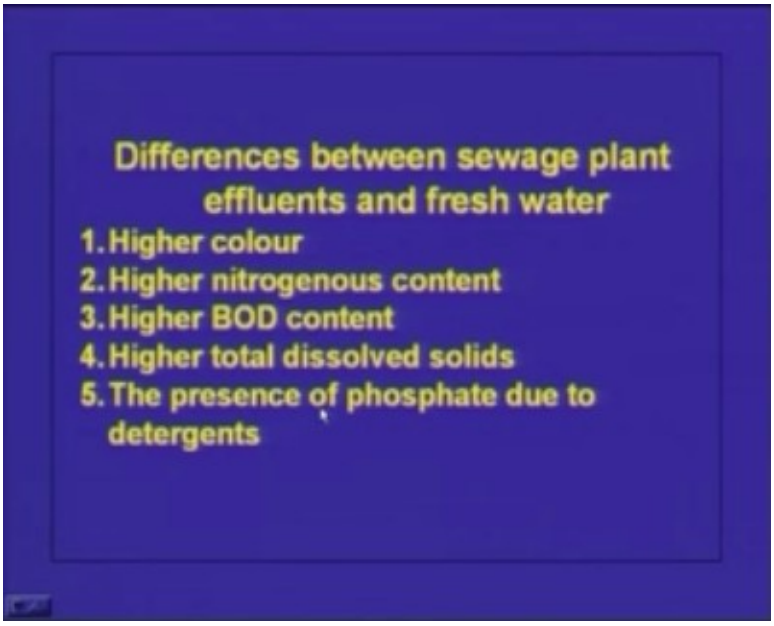

The treated effluents will be having high color and higher nitrogen content, high BOD and high total dissolve solids and the presence of phosphate etc due to detergents. These components will be present so we should be careful when we use the treated effluents for the processes as it may adversely affect the product.

How can the industry do the conservation of water?
They can conserve water by following these steps as listed below.

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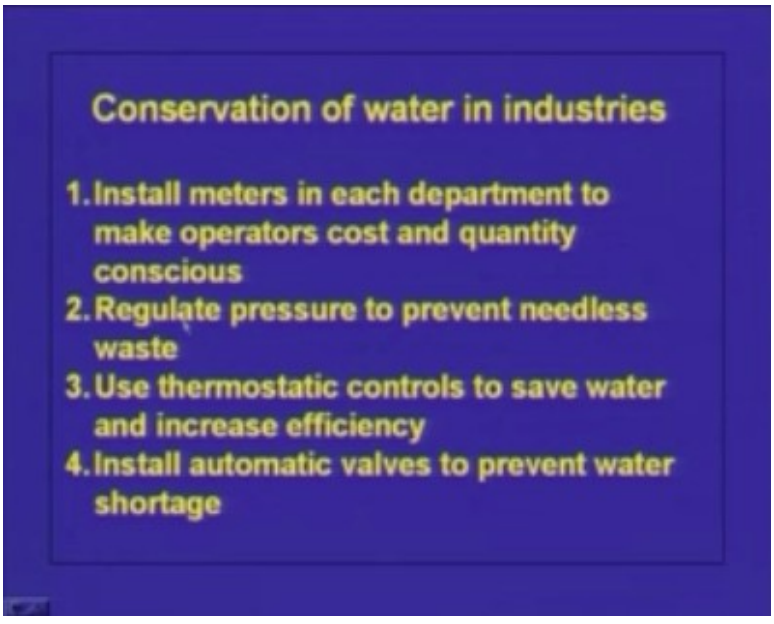

First one is install meters in each department to make operators cost and quantity conscious. So, if you know that what is the amount of water we are using then definitely they will be having some feeling when they waste the water. Second one is regulate pressure to prevent needless waste. If the water supply system is having high pressure so little opening can waste lot of water so regulate the pressure to prevent needless waste. Third one is use thermostatic control to save water and increase efficiency. Fourth one is installing automatic valves to prevent water shortage and the next one is use spring closing sanitary fixtures to prevent constant or intermittent flow of unused water. Sixth one is De-scale heat exchangers so that cooling water quality quantity can be reduced because if the heat exchangers are not working properly then the industry might need more and more cooling water. The seventh one is insulate pipes so that water is not left running to get it cold or hot.

What will happen during summer times?
Naturally in the overhead tank will be getting heated up. If some people want to wash their face or something like that they will be coming and opening the tub so immediately whatever water is coming from the overhead tank will be very hot. Therefore, what they will do is they will allow the water to flow for sometime so that they will get some cold water. Similarly in winter the case is the reverse. Initially whatever water is coming will be very very cold and after sometime it will become relatively cold. So in that process we will be wasting lot of water so if you can insulate the pipe then we can avoid such water loss.

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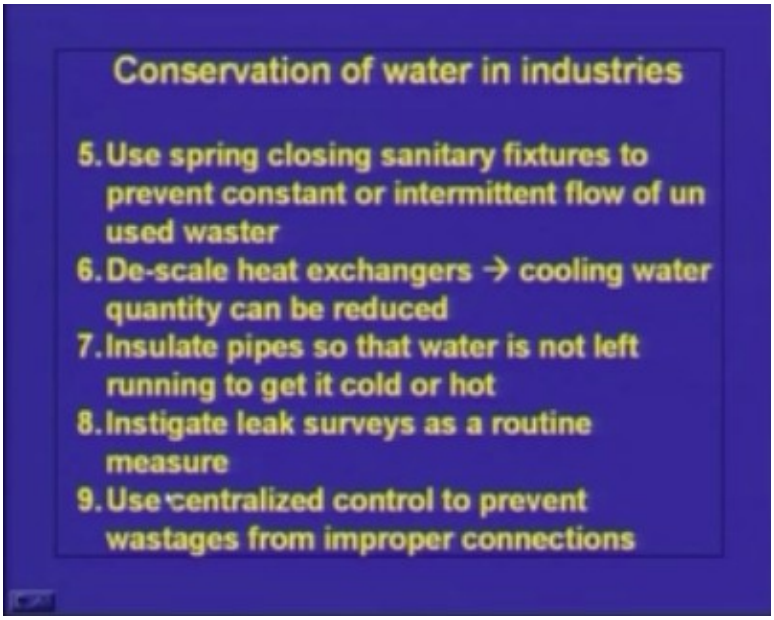

The eighth point is instigate leak surveys as a routine measure. In industries lot of pipe networks are there so unless we easily locate the leaking points lot of water will be getting lost just like that. Thus, instigate leak surveys as a routine measure then use

centralized control to prevent wastages from improper connections, re-circulate cooling water, reuse water, use high pressure, low-volume rinse for more efficiency and the last one is recondition wastewater.

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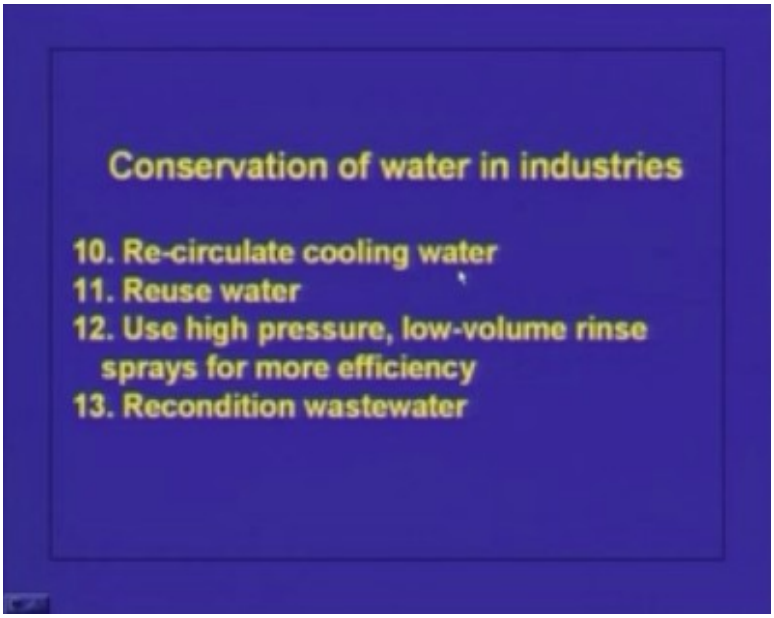

These are the ways by which the industry can conserve the water use.
Once you conserve the water the water is saved so naturally the wastewater volume whatever is coming out of the industry will be reducing drastically so definitely the treatment cost will be reducing and its adverse effect on the environment also will be reducing.

The last one is elimination of batch or slug discharges of processed water. So first we will see what this slug discharge is. In a wet manufacturing of a product one or more steps may be repeated. The production of significantly higher strength and high volume waste is very common in such cases. If this waste is discharged in a short period of time that is know as slug discharge.

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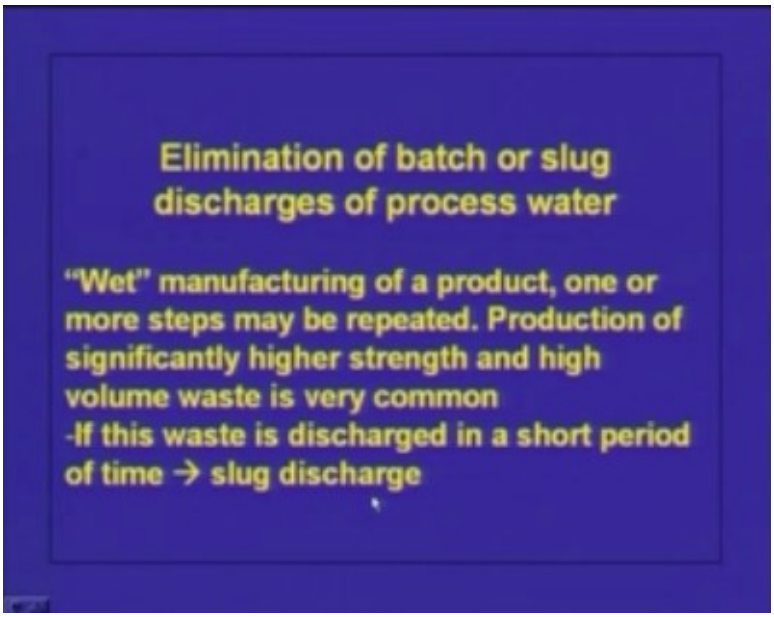

I will explain once again.

In wet manufacturing process, wet manufacturing process means the raw materials are coming in contact with water so the process is wet. Most of the processes will be operated in batch mode. So sometimes by some mistake the mixing may not be proper or whatever quantity we have added to the raw material may not be proper so definitely whatever product is generated by the process will not be meeting the required standards. Hence after they realize that something has gone wrong they will be discharging that entire batch of chemicals and the water to the effluent discharged pipeline so that will be increasing the volume of wastewater and all the chemicals or all the raw materials present in the process which are intended to convert to product so everything will become a waste.

If the industry discharges it immediately then it is coming as a slug discharge. So it is always advisable to eliminate such slug discharges because if you go for this slug discharge definitely the volume of the wastewater will be increasing and the strength of the wastewater will be increasing moreover you are losing so much of raw materials and that will be causing loss to the industry and sometimes it will be unavoidable.

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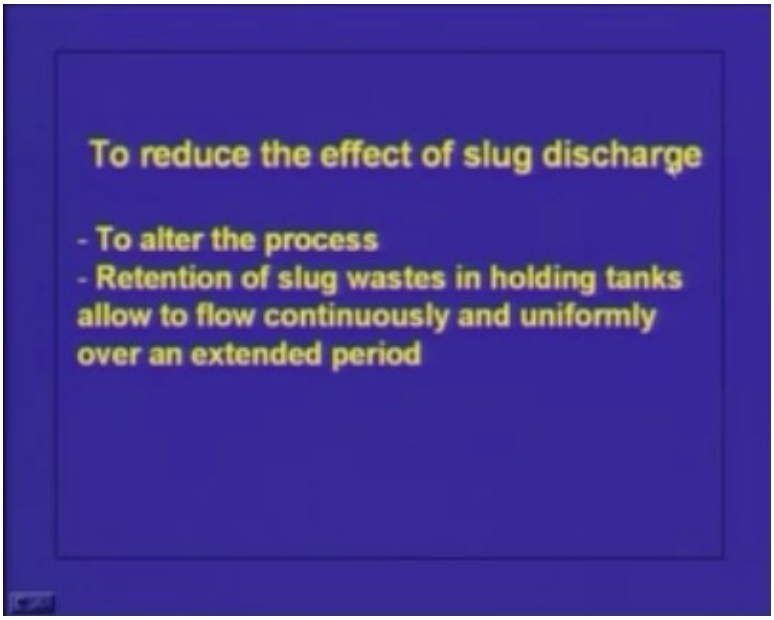

So how can we reduce the effect of such slug discharges?
One is to alter the process and the other one is retention of slug wastes in holding tanks and allow to flow continuously and uniformly over an extended period. if you allow the slug discharge as such to the effluent stream then the volume will be increasing drastically for a short period of time and the concentration will be very very high so that will be affecting the treatment unit. So what we can do is hold it for sometime and allow it to go out uniformly at a constant rate so that the volume variation and the strength variation can be reduced.

Till now we were discussing about how the industry can reduce the volume of the wastewater. Not only the volume but also the strength of the wastewater is very very important. For example, if you have a small volume of water but it is having such a high concentration of pollutants then in such a case the treatment will be very very difficult and the cost involved also will be very very high. So apart from reducing the volume of the wastewater it is essential to reduce the strength of wastewater because the strength of wastewater if we can reduce the pollutant whatever is coming in the wastewater is nothing but the raw materials used in the production or the products whatever is generated which was not able to recover from the system so these are coming as waste. So if we can reduce the strength of the wastewater in the industry itself then industry is saving either the raw materials or the products so it is very very essential.

Now we will see how the industry can practice this strength reduction. This is what I have already mentioned. Waste generated is nothing but the resources wasted.

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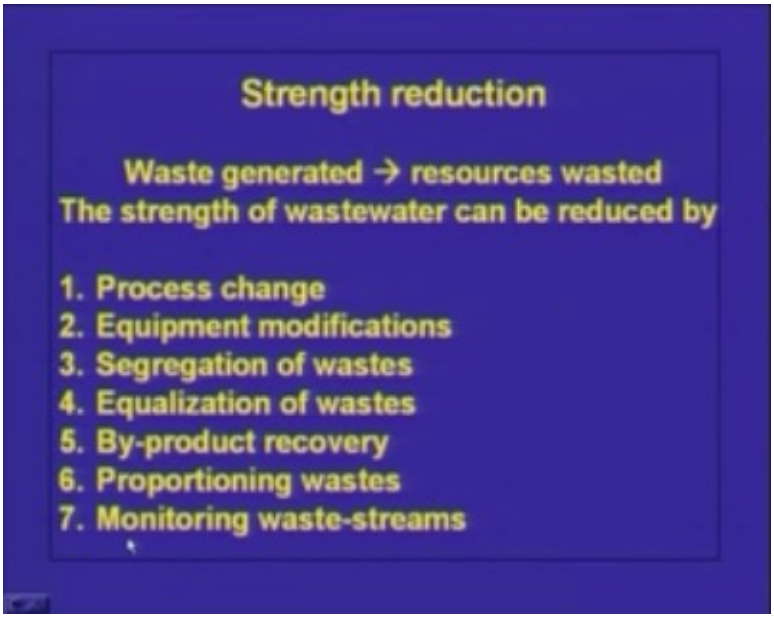

So the strength of wastewater in the industry can be reduced by following methods:

- process change
- equipment modifications
- segregation of wastes
- Equalization of wastes
- By-product recovery
- proportioning wastes
- monitoring waste streams

We will see one by one in detail. First one is process change.
How can a process change reduce the strength of wastewater?
We will take the case of tanning or tanneries. We know what a tannery is. This is the treatment used for leather manufacturing. In the tannery they will be using different types of chemicals. So if we can replace the chemicals like lime and sulfides with other chemicals like amines and enzymes the strength of the wastewater can be reduced drastically thus the amount of lime and sulfides used in tanneries are very very high. But if you can replace this lime and sulfide by amines and enzymes the quantity required will be very very less. The only thing is the raw material cost will be high. But if the industry is concerned about the environmental safety or concerned about the environment so they don’t mind changing the process.

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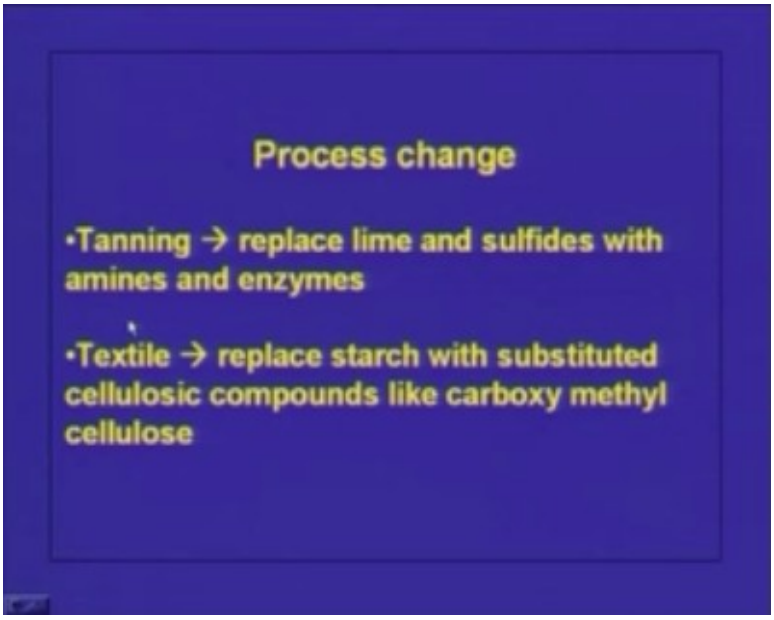

Similarly if you talk about the textile industry they use lot of starch. So if you can replace the starch with substituted cellulosic compounds like carboxy methyl cellulose the strength of the wastewater can be reduced drastically because whatever starch that is used in the textile industry only a very small portion is being used by the product and all the remaining is coming out as the waste, that will be increasing the COD or Chemical Oxygen Demand of the waste drastically. But if you can remove the starch with this carboxy methyl cellulose the strength of the wastewater or the COD of the wastewater can be reduced drastically. These are other examples of process change.

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Coming to the metal plating industry this is another large group of industries which cause lot of pollution, change copper cyanate solution to copper acid solution because in most of the industries cyanide is used as a complexing agent. If cyanide is present the copper solubility can be increased drastically because the cyanide will be making a complex with copper like this copper cyanate complex. So instead of this one if you can make acid copper solutions at acidic pH all the metals will be having high solubility. So, with the copper if you make acidic solution definitely it will be giving you high solubility and reduce the strength of waste.

Similarly copper CN2 strike can be replaced with nickel strike that is another way. Another one is if you are using a molten cyanide bath it can be replaced by a carbo-nitriding furnace because we know that if cyanide is present in the wastewater the treatment will be very very difficult. These are some of the process modifications and I have listed some more here.

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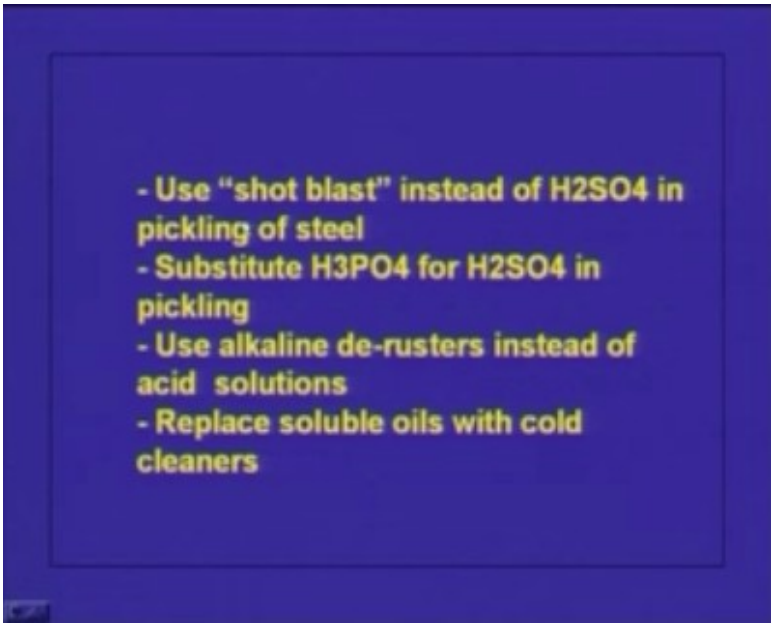

Use shot blast instead of H2SO4 in pickling of steel and substitute phosphoric acid for sulphuric acid in pickling because if sulphuric acid is there we know that it is a very very strong acid so if you can replace it with phosphoric acid the treatment will be much easier. Use alkaline de-rusters that means if you want to remove the dust go for alkaline de-rusters instead of acid solution and another one is replace soluble oils with cold cleaners.

If you see the industrial processes we can write hundreds of replacements as these. By using this type of replacement we can reduce the strength of the wastewater considerably. Now we will see the next point. If you want to reduce the strength of the wastewater it can be achieved by equipment modification. Change in the equipment can reduce the strength of the wastewater. I can give a very simple example.

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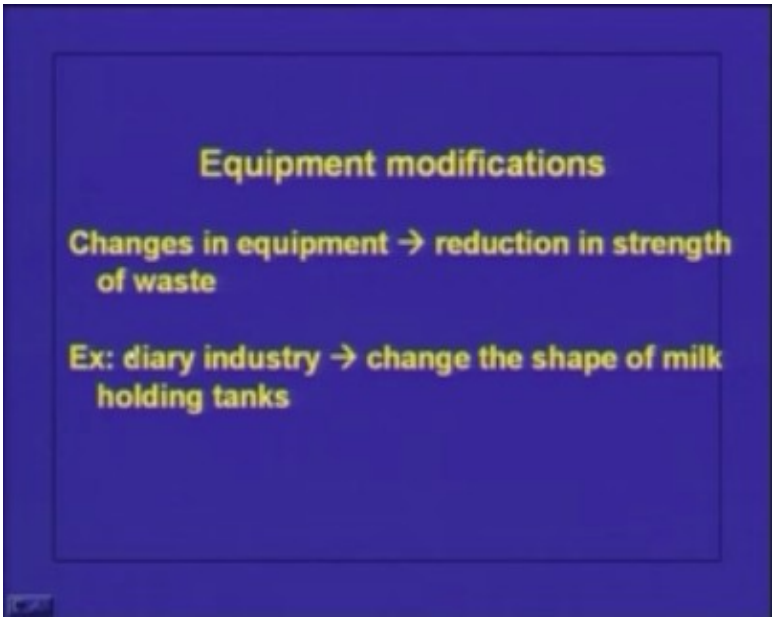

For example, let us take the dairy industry. In dairy industry we know that the milk is stored in various types of containers. So instead of a rough surface container if you make the container design in such a way that everything is very smooth then whatever milk is there in the container when we empty it everything will be coming to the tank and whatever milk left over in the container will be very very less and after emptying of the container the container will be going for cleaning so if some milk is left over in the container then definitely the washed water will be having lot of milk definitely the strength of the waste will be very high. But if you make a slight variation in the design of that container the waste strength can be reduced drastically.

Similarly there are different ways. By changing the equipment or by modifying the equipment the strength of the wastewater can be reduced. Third one is segregation of wastes. This we have already seen when we were discussing the volume reduction. So segregation also helps to reduce the strength and/or the difficulty of treating final waste from industry.

What will happen if we mix up all the waste together? For example, if you mix up the electro plating wastewater, for example copper cyanide with a domestic wastewater what will happen is we cannot go for biological treatment process immediately because cyanide is very very toxic and copper is very toxic and when we mix it with organic matter that also will be forming complexes with this heavy metal so it is always advisable to segregate the waste so that will be reducing the strength of the waste as well as it will be increasing the treatability of the waste. When we mix all process waste together the waste will become so complex. But if you can segregate the waste separately the treatment will be much easier. Industrial waste can be classified into strong wastes in small volumes, weaker wastes in large volumes.

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For example, we can take the case of textile industry, metal plating industry etc.
In metal plating industry the plating time, whatever waste is coming out will be very very strong but the waste coming from the cleaning time will be relatively weaker. So it we can segregate this waste then the volume of waste can be reduced as well as the strength of the waste can be reduced.

Next one is equalization of wastes. Sometimes the waste will be having high pollutant concentration and at other times it will be having low pollutant concentration. If we can equalize the waste we may not be reducing the overall strength of the waste but for a particular time if you see we will not be getting a very high strength wastewater we will be equalizing the effluent. So, equalization of the waste also can reduce the strength of the wastewater.

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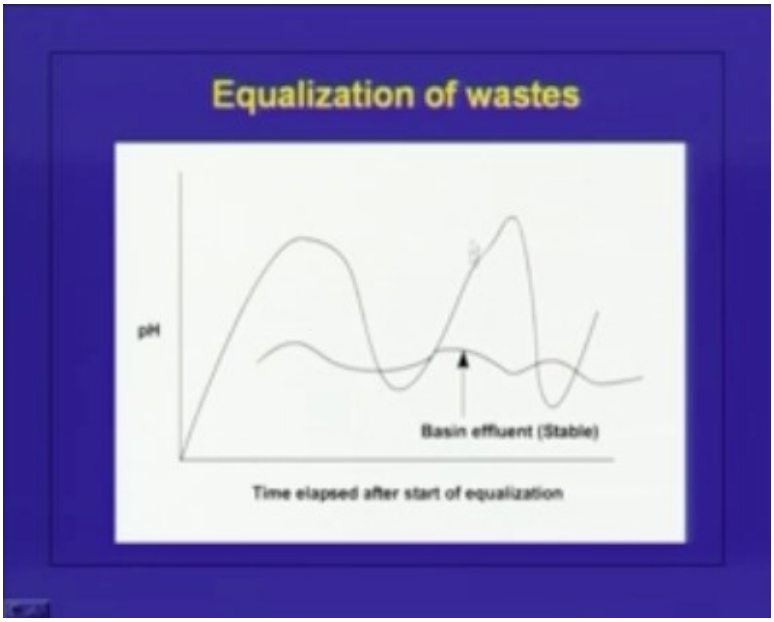

It will not be reducing the overall quantity of the pollutant present in the system but at a particular time if you take the concentration of the pollutant will be reducing.

Next one is by-product recovery. We have already seen that waste is nothing but resources out of its work place. So if we can replace the resources into its original place that is nothing but waste treatment or resource recovery. If you can recover the resource so definitely the strength of the waste will be decreasing. Waste is nothing but resources out of place. If we can put the resources back waste minimization and economic benefits can be achieved.

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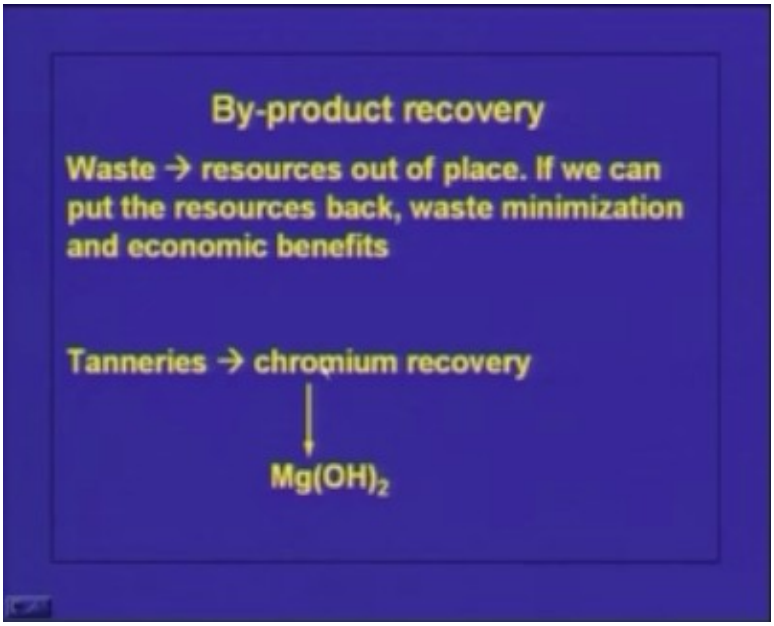

For example, in the tanneries they will be using lot of chromium for the tanning purpose. So if we can recover this chromium because you know that this chromium is a toxic heavy metal we are not supposed to discharge chromium containing wastewater to land or existing water bodies the minimum discharge level is 0.5 milligrams per liter or so. So if you can recover this chromium using lime or magnesium hydroxide then the strength of the wastewater will be reducing moreover the chromium thus recovered can be reused for the process again. That will be giving some economical gain also.

The next one is proportioning of wastes.

- Proportioning the discharge of concentrated wastes to the mainstream
- Especially for toxic hazardous wastes
- To prevent the adverse effect on treatment plants

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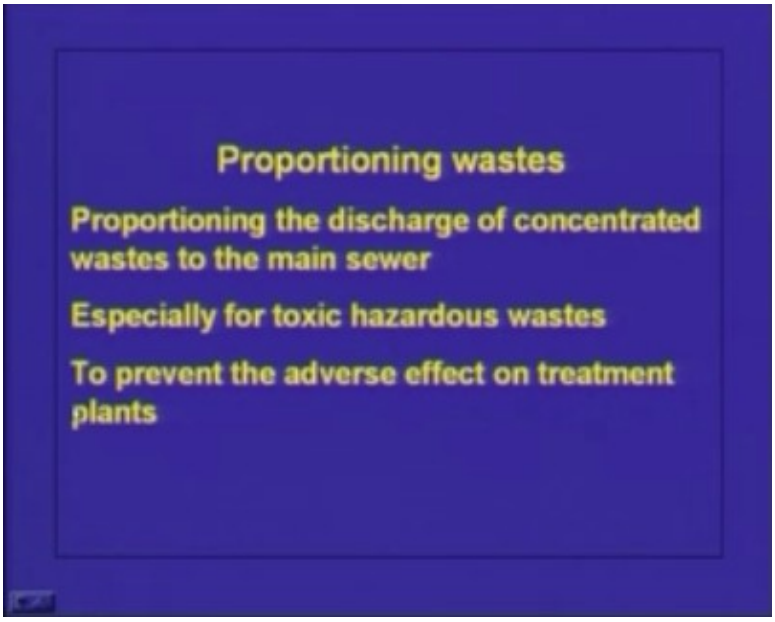

Sometimes what will happen is some processes will be generating lot of toxic chemicals so if you allow that waste immediately to the treatment plant then the toxic concentration will be raising in the treatment plant and if it is a biological system definitely the system will be getting affected.

In chemical system the process will not be getting affected but the efficiency of the system will be coming down. But in biological system the microbes as such will be affected and to regain the original efficiency it will be taking much time. So what we can do is store it and proportion it so that the strength of that particular pollutant will be constant throughout and it will not be creating as much adverse effect as if it is discharged once for all.

The next one is monitoring of waste streams. It is always advisable to go for remote sensing devices for the operator. Sometimes we know that the waste quantity will be very high or the strength will be very high so by seeing the characteristics of the wastewater the operator can either stop the waste flow or reduce the volume of flow or redirect the flow depending upon the characteristics.

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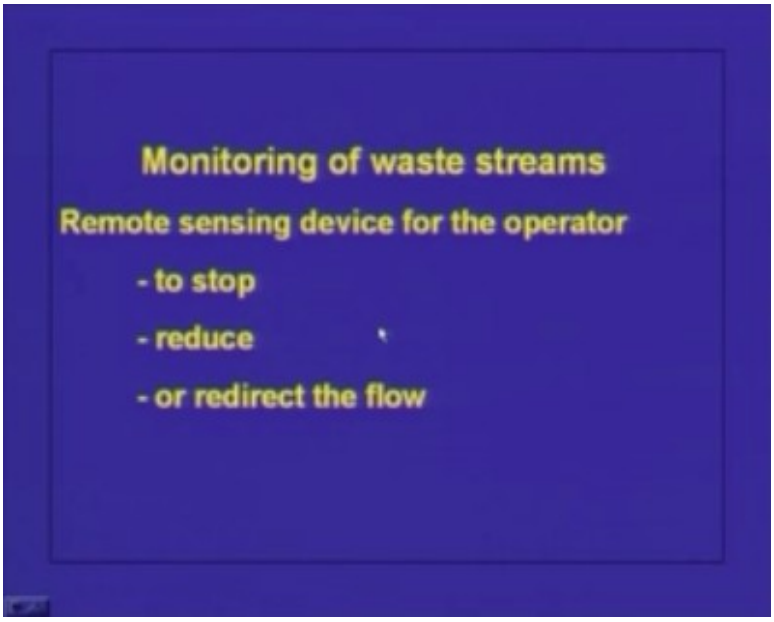

Therefore, it is always advisable to have a remote sensing device with the operator of the wastewater treatment plant. In industries accidental spills is a common phenomena. It is always advisable to avoid these accidental spills. How can we avoid such things?
Make certain that all pipelines and valves in the plant are clearly identified. If some spillage is taking place or some leak is taking place then if we know which valve that is then we can just close it immediately. By doing this one can avoid such type of an incident.

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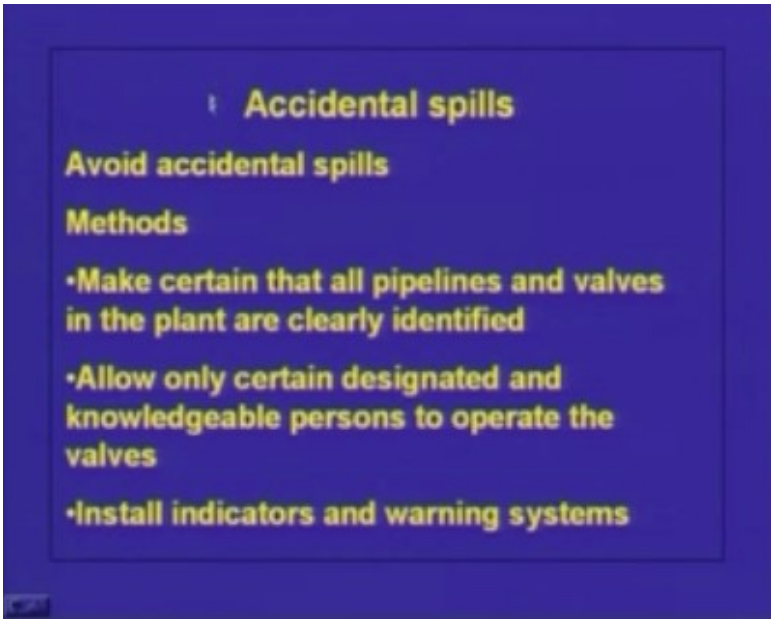

Second one is allow only certain designated and knowledgeable persons to operate the valves. Third one is install indicators and warning systems and provision for detention of spilled wastewater in holding basins or lagoons. Thus, even if the spill is taking place if you have proper provision so that the spill will not be getting spread then the accident or the concentration of the waste can be reduced. Another one is monitor effluent quality and quantity. The last one is establish a regular maintenance program because most of the time the accidental spills, leaks etc happens because of improper maintenance. So, if we can establish a regular maintenance program most of these incidents can be avoided.

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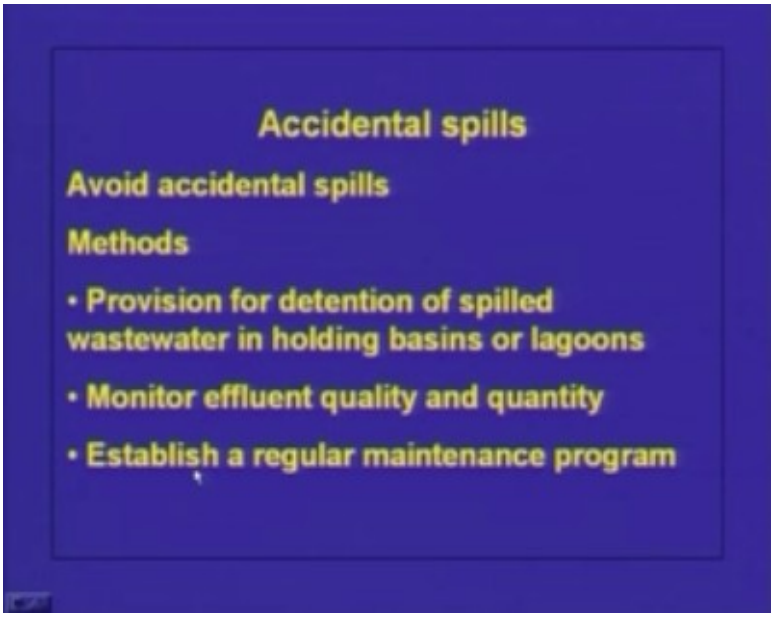

The third important point in industrial wastewater treatment is the neutralization. We have seen that industry can go for volume reduction strength reduction. But we know that different processes will be using different types of chemicals and they will be using acids and alkalis in different processes.

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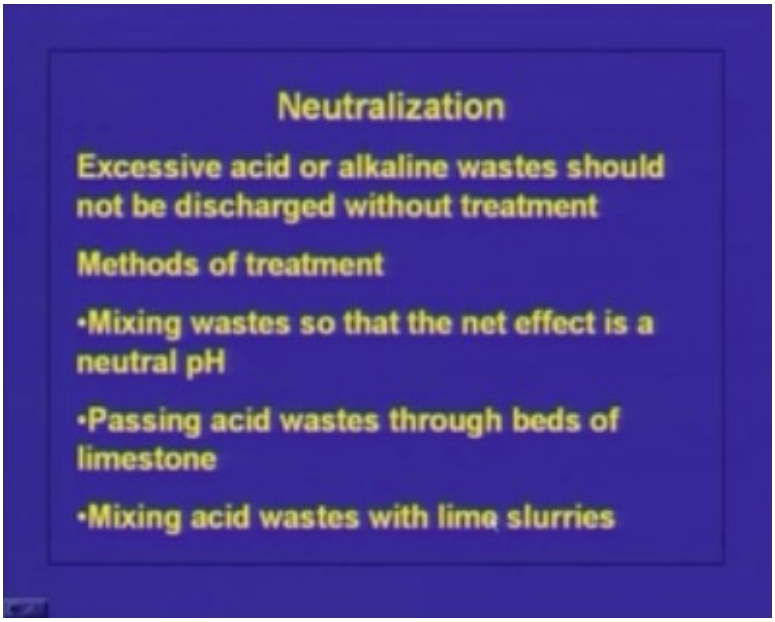

Therefore if industrial wastewater is coming and if you want to discharge it to the municipal wastewater treatment system and if it is an acidic waste of alkaline waste it

will be having adverse effect on the treatment system. So before sending it to the treatment system it is always advisable to neutralize the waste. How can they neutralize the thing? If the industry is using acid waste in some process and alkali waste in some other process if they can mix it properly that itself will be taking care of the neutralization.

What is the purpose of this neutralization?
Excessive acid or alkaline wastes should not be discharged without treatment. Methods of treatment include:

- Mixing wastes so that the next effect is a neutral pH
- Passing acid wastes through beds of limestone so that it will be getting neutralized
- Mixing acid wastes with lime slurries or
- Adding proper quantities of sodium hydroxide or sodium carbonate to acid wastes so that it will be getting neutralized or
- Blowing waste boiler flue gas through alkaline wastes. The waste boiler flue gas will be containing lot of carbon dioxide. When carbon dioxide mixes with water it will be generating carbonic acid and that carbonic acid will be reacting with the alkaline waste and it will be neutralizing it
- Adding compressed carbon dioxide to alkaline wastes

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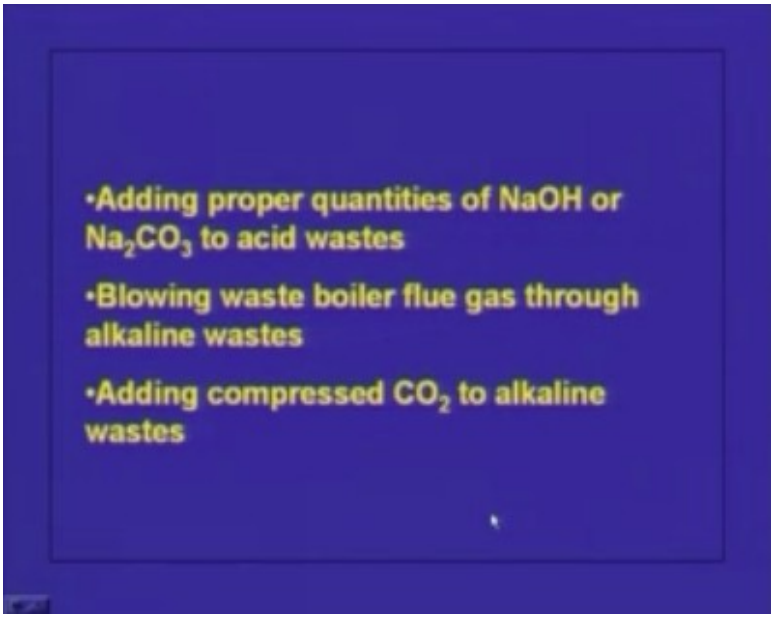

These are the various methods that can be practiced to neutralize waste. These are the chemical reactions involved (Refer Slide Time: 39:43).

If sulphuric acid is there if you add calcium carbonate or pass this acid waste through limestone then the calcium sulphate and carbonic acid will be formed depending upon the

pH. If the pH is low carbon dioxide will be escaping to the system otherwise it will be getting converted to bicarbonate and carbonate.

This is the other reaction (Refer Slide Time: 40:12). Similarly, if sodium hydroxide is there if you pass carbon dioxide it will be forming sodium carbonate and if you have acid waste and alkali waste if you combine both of them then you will be getting a salt and water.

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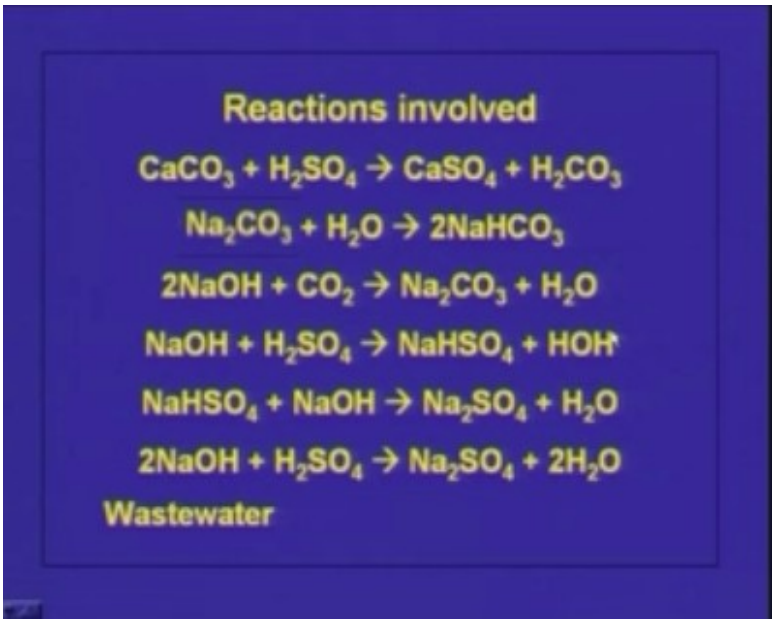

This is another process (Refer Slide Time: 40:29). We have seen that neutralization can be achieved by adding either alkali or acid or if you have acid waste and alkali waste mix then it properly according to the proportion so that it will be getting neutralized.

We have discussed in detail that the industrial process will not be uniform throughout so definitely the waste quantity and quality will be varying with respect to time. But whenever we discuss about or talk about the treatment plant we always design it for the average wastewater characteristics both in quality and quantity. So if you want to treat the industrial wastewater what should we do is we should have some equalization mechanism by which you can maintain the quality and quantity of the wastewater almost uniform before sending it to the treatment plant. That is the purpose of this equalization and proportioning.

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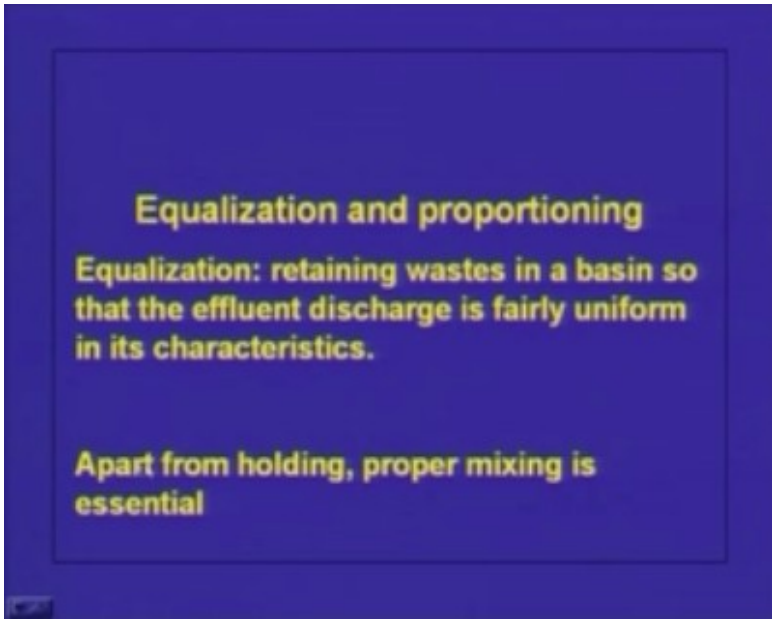

Equalization is retaining wastes in a basin so that the effluent discharge is fairly uniform in its characteristics. Once again, equalization is the retaining of wastes in a basin so that the effluent discharge is fairly uniform in its characteristics. So, apart from holding because only holding will be giving you a proper equalization, proper mixing is also essential because some wastes will be containing certain chemicals and other wastes will be having something else so if you want to have a uniform nature we have to mix it properly. This is the graph showing how the pH variation is in a plating bath waste when we average it for twenty four hours, eight hours and instantaneous discharge.

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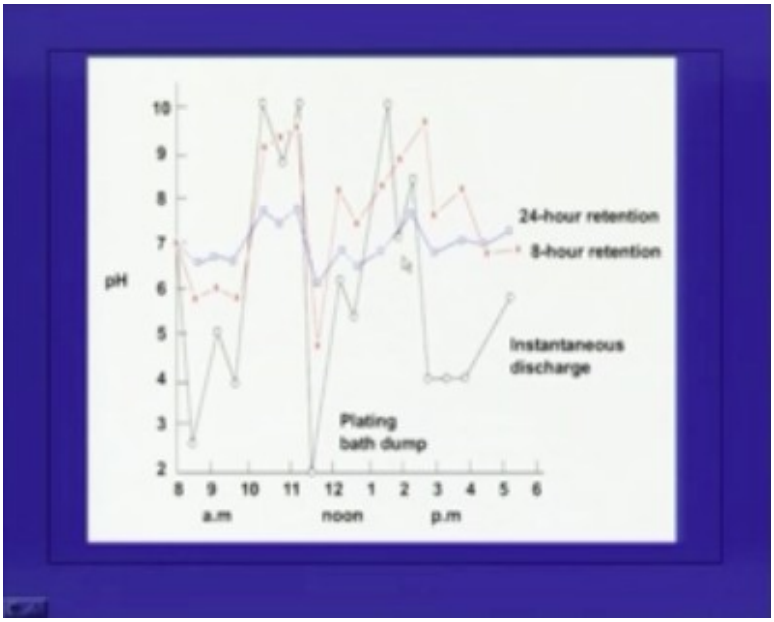

If it is an instantaneous discharge then pH variation is like this. It is going up and going up and down like this (Refer Slide Time: 42:34). Sometimes the pH is up to 10 and sometimes it will be coming below two so that is the instantaneous discharge. But if you take eight hour retention then the thing is like this. This red line shows that the variation is somewhat damped but even then you can see the peaks. But if you can hold it for twenty four hours you will be getting almost uniform flow characteristics. So this is the purpose of equalization chamber.

I told you that not only holding but mixing also is essential. Mixing can be achieved by

- proper distribution and baffling
- mechanical agitation
- aeration and
- combination of all the three

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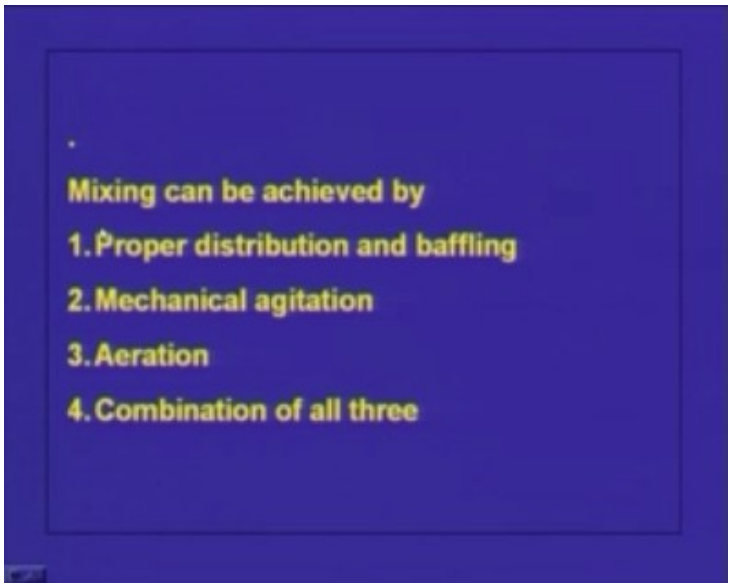

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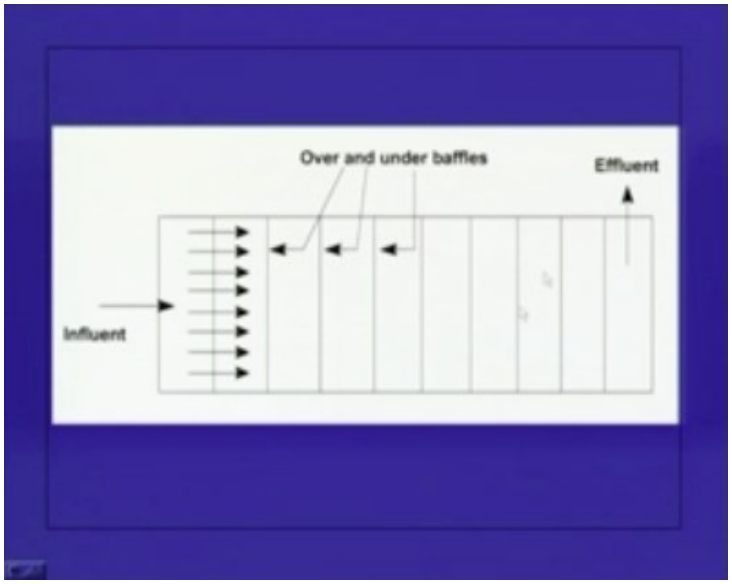

This is a system of baffles. the baffles is put over and under baffles so that the flow will be going like this from underneath then it will be overflowing like this so proper mixing will be taking place. this is another type of mixing (Refer Slide Time: 43:34) paddle and motor assembly, whatever we do in coagulation flocculation we have seen in detail that type of mixing also can be practiced. We have seen how we can reduce the volume strength and what is the purpose of neutralization and equalization. Once this is done we will know the characteristics of the waste and quantity of the waste. We have also seen the entire treatment options that are available. Depending upon the waste characteristics

we can go for the physiochemical processes or biological process or even advanced wastewater treatment to meet the effluent discharge standards. Any of these treatments namely the physiochemical processes, biological processes or advanced wastewater treatment can be employed for industrial wastewater treatment depending upon the characteristics of the wastewater.

Now we will be discussing about another important aspect about the industrial waste management. Nowadays this concept is coming up the industrial complexing for zero pollution attainment. This is an important concept.

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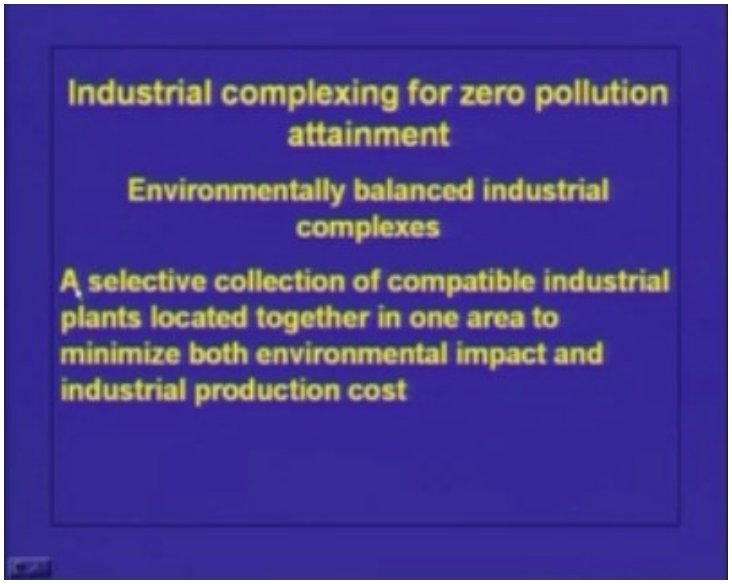

Here what we are doing is make environmentally balanced industrial complexes.
So first we will see what is an environmentally balanced industrial complexes. It is a selective collection of compatible industrial plants located together in one area to minimize both environmental impact and industrial production cost.

Once again, an environmentally balanced industrial complex is a selective collection of compatible industrial plants located together in one area to minimize both environmental impact and industrial production cost. How can we achieve that one? We have to use raw materials. In any industry there will be raw materials, there will be products and by-products. the waste or the by-products of one industry is being used as a raw material for another industry or the wastewater of one industry is being used as the water for other industry then what will happen is we can reduce the waste treatment and we can reduce the cost of the raw material that is the basic concept of this environmentally balanced industrial complexes.

The objective of complexes is to reduce the environmental impact of the industries and to reduce the cost. So if you want to meet the objective this can be met by utilizing the waste materials of one plant as the raw materials for another with a minimum of

transportation, storage and raw material preparation. Because if we can keep the industries in the same place what will happen is the raw materials of one industry are the waste materials from one industry so we can reduce the transportation cost, storage cost and raw material preparation cost and when a manufacturing plant neither treats its wastes nor stores or pretreats certain of its raw material the overall production cost will reduce significantly.

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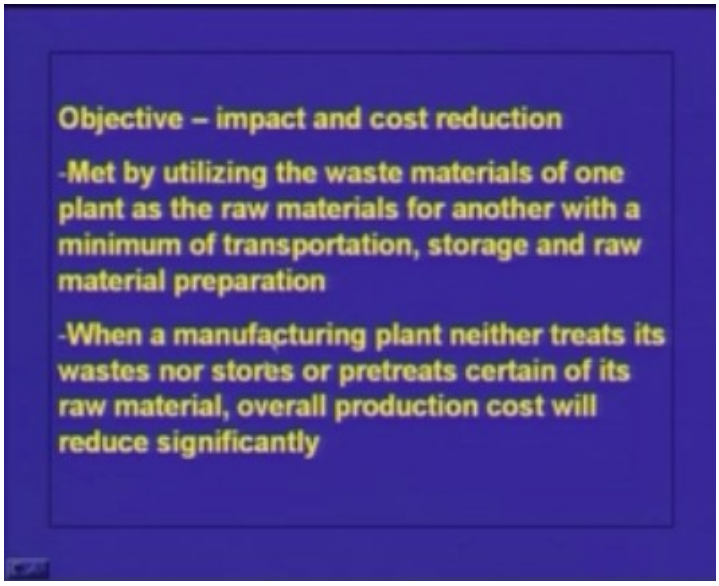

So this is the advantage of these environmentally balanced industrial complexes. Neither they have to treat the waste nor they have to store it or they have to pretreat the raw material so definitely the cost of production will be reducing so the benefit will be increasing.

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Industrial complex principles and concerns:
Pollution control cost will be very less compared to overall production cost because whatever waste is generated is used by other industries. But if you see each industry separately the pollution control cost will be very very high. What will happen? The industry may think that why should I go for producing this product and incur loss so it is better to stop that one. But if you have an environmentally balanced industrial complex what will happen is this type of a thought will not come because the waste generated will be used by our industry as its resources.

So, how can we take care of these industrial complexes? By proper environmental management the decision can be reversed. Whenever we go for the industrial complexes it is advisable to have this large water consuming industries like tanneries, fertilizer industry etc because these industries will be having large water treatment costs. But if this water can be utilized by other industries definitely the cost of production will be coming down drastically.

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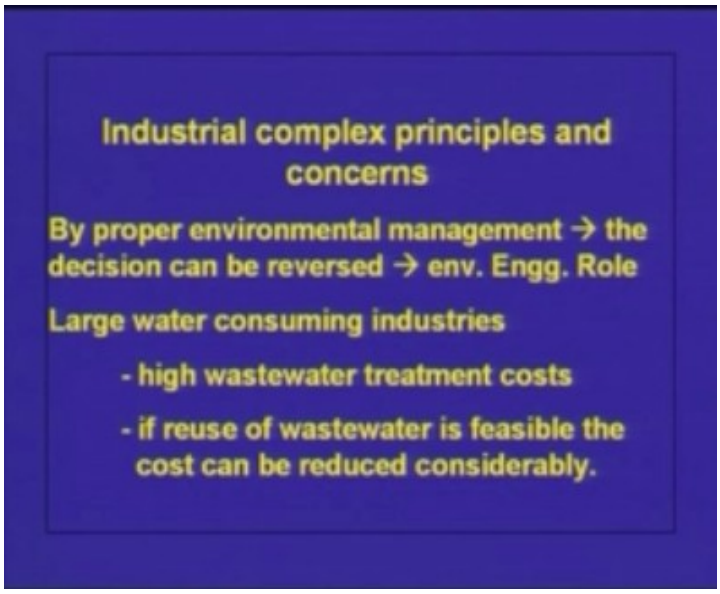

But when we talk about establishing this environmentally balanced industrial complexes their will be some difficulties. The most important one is compatibility because we have to select the industries in such a way that one raw material is used by other industry's raw material which is known as the compatibility.

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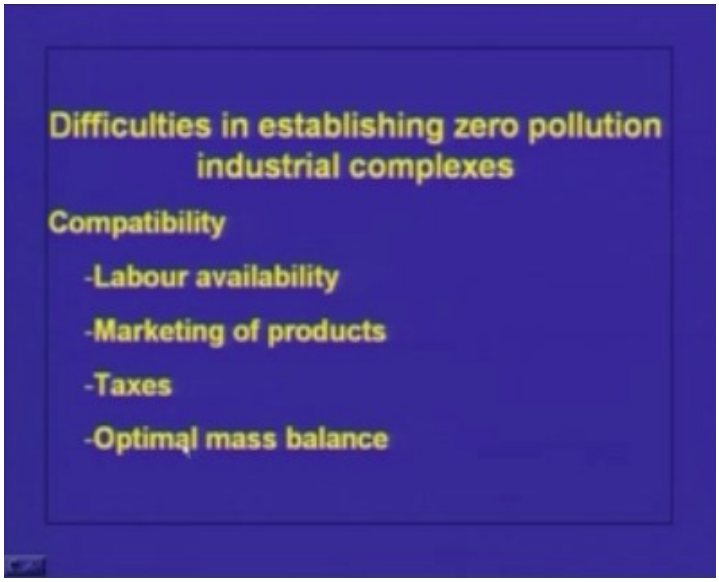

Then we have to think about the labor availability, marketing of the products and what are the taxes involved and optimal mass balance. We have to select the industry in such a way that all the waste generated by one industry is used as the raw material by other

industry so optimal mass balance is also very very essential. I will give one or two examples of these complexes. First we will discuss about a sugarcane industry.

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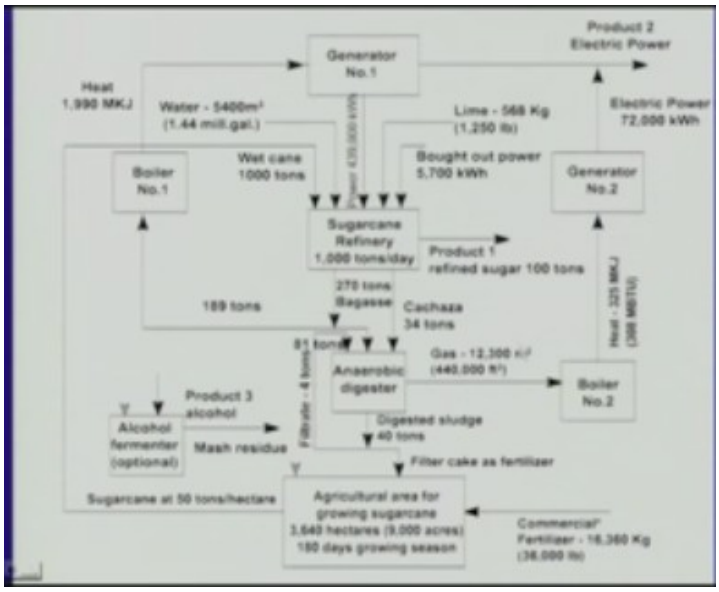

This is a sugarcane refinery so you want to have water, you want to have wet cane and we want to have lime and lot of power is essential so everything is coming here this is the sugarcane refinery. It is having a capacity of thousand tons per day. So, first one is we will be getting refined sugar. If we use thousand tons of sugarcane we will be getting around hundred tons of sugar so this is your product one. As a result what will happen is you will be having so much of waste; one is bagasse and another one is cachaca, this is nothing but the insoluble sugar in the lime, this one will be going for the anaerobic digestion, this is one of the treatment. Here lot of gas will be generated. This can be used by a boiler for the generation of power and from the anaerobic digestion the filtered cake will be coming. That means the stabilized sludge which can be used for agriculture purpose and whatever filtrate is there will be the liquid waste that will be going back to this system again.

Here (Refer Slide Time: 50:53) we can see that the bagasse is coming and from here it is going to another boiler, this bagasse can be utilized by that boiler and lot of energy is recovered. Here we can see that 1990 MKJ heat energy is released and here again in this agricultural area we are using this anaerobic sludge as the manure and whatever be the area here it will be giving so much of sugarcane so that can be used for the alcohol fermentation. The same thing can be used as sugarcane for the sugar industry.

Therefore as we can see here nothing is getting wasted, whatever is the raw material or the waste materials coming out of this one is being used by other processes and the resources or the products are generated. This is an example of environmentally balanced

industrial complex. Similarly, for a fertilizer plant we can make the same type of an arrangement.

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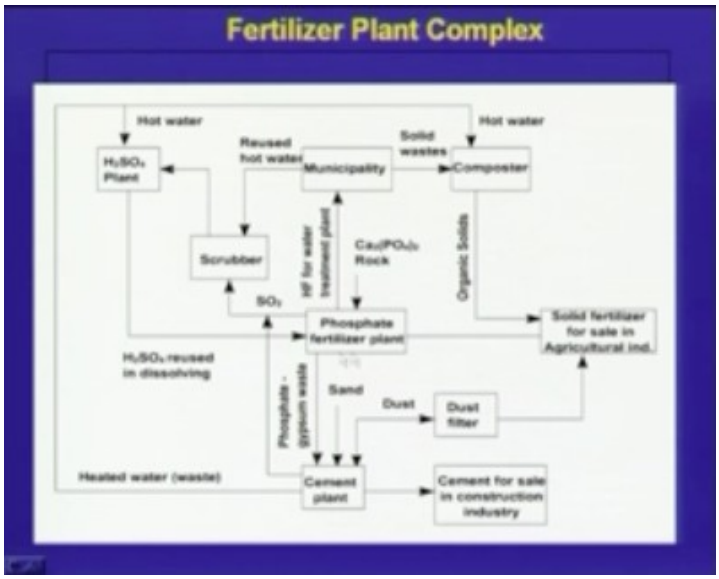

Similarly we can show many examples of these environmentally balanced industrial complexes so that the total waste production will be almost zero. That is the concept of this zero polluting industrial complexes. Another important point we have to consider is the common effluent treatment plants whenever we talk about the industries. Then the main objective is to reduce the treatment cost to be borne by an industrial unit to a minimum while protecting the water environment to a maximum.

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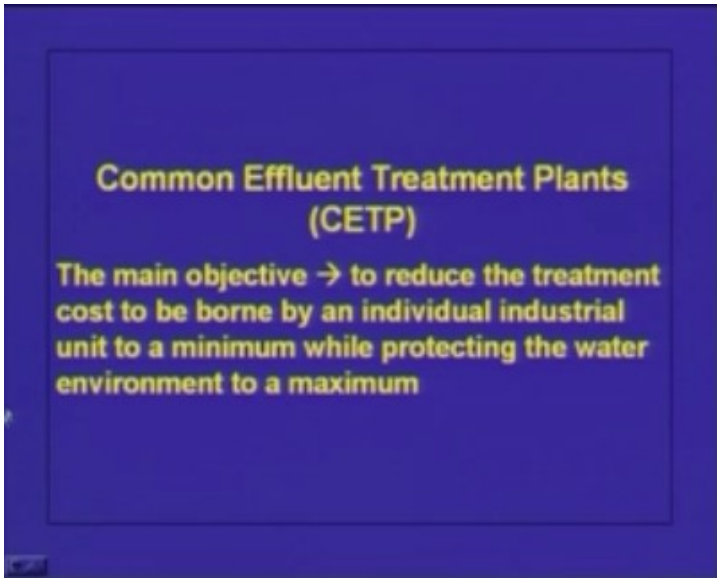

It is because whenever we talk about the small scale industryfor them it is very very difficult to have their own treatment plants, the cost involved will be so high and their scale of production is small. So when they have the waste treatment plant the overall product cost will be increasing too much and they will not be able to survive in the market. In such cases these common effluent treatment plants are very very useful. Here what they do is all the waste from various industries will be collected and treated centrally.

What all are the advantages?
It will be reducing the capital and operating cost and advantage of having trained personnel to take care of the unit, avoiding land constraints in individual industries because if individual industries go for separate treatment plants lot of land requirement is there so that can be avoided and so much of domestic wastewater will be coming to such plants so this domestic wastewater can contribute nutrients and dilution potential making an industrial wastewater more amenable to degradation. This is another advantage and the last one is domestic wastewater provide a continual seed source to the biological unit

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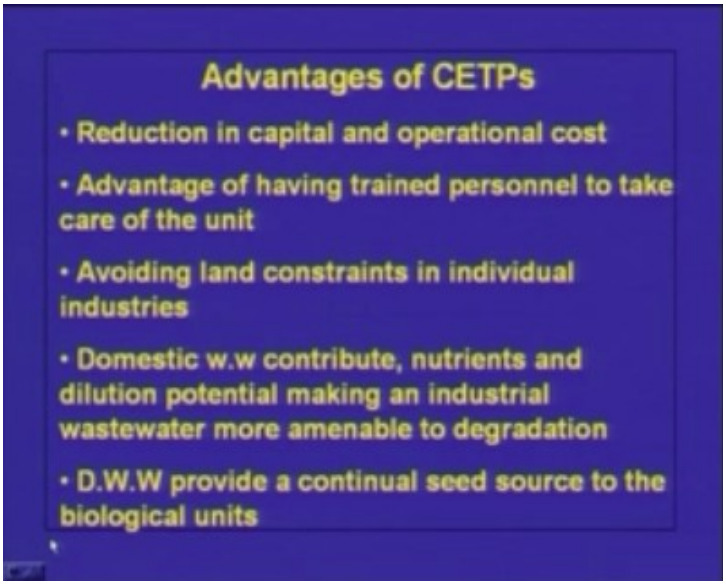

This is because most of the industrial wastewater will be containing hazardous waste that will be adversely affecting the biological treatment system. But if we can supply domestic wastewater then the microorganism will be continuously getting seeded so that the system efficiency will be more.

Now, if you want to go for such type of a treatment system, common effluent treatment plants, who will be paying for that because many industries are contributing to the pollution to that treatment plant so who will be taking care of that one. For example, in a municipal wastewater treatment plant the residents of the municipality will be paying the taxes so they will be paying for the treatment plant also. But when we are putting up a Common Effluent Treatment Plant that will be bearing the cost, definitely the industry has to bear the cost. But many industries are involved; many types of wastes are coming so how can we proportion the cost of this treatment.

There are various methods for that one. One is equitable sharing of the financial burden. If many industries are present each industry will be sharing equal amount. For example, if the waste generated by each industry is of same quantity and quality this is acceptable. But if the quantity generated by various industries is different then nobody will be accepting this method.

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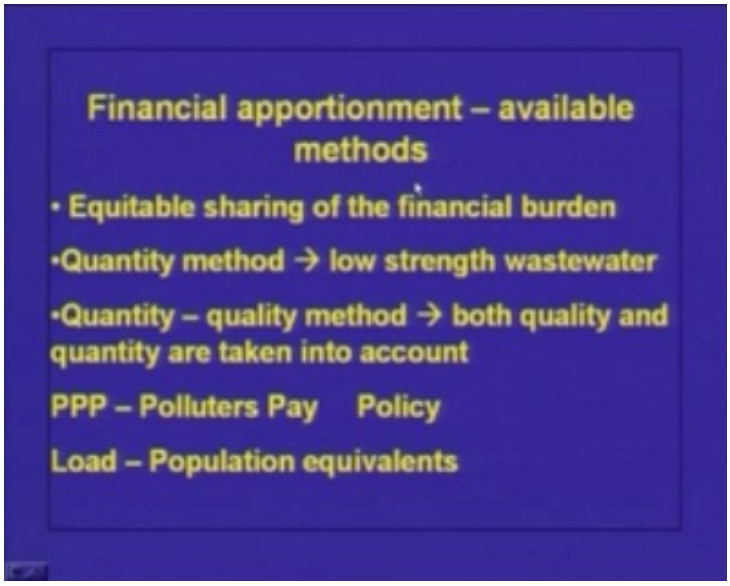

In such cases we can go for quantity method. This is applicable only for low strength wastewater. So we will be charging the industry, the industry which is producing maximum waste have to pay more and the industry which is producing low volume have to pay less. So based on the quantity of production we can proportion the financial burden. In certain cases what will happen is some industry will be producing low volume but the strength of the waste will be very very high and vice versa. In such cases we how to go for quantity quality method both quality and quantity are taken into account then only it will be possible.

In most of the cases this is what is practiced. Both quantity and quality are taken care and all the CETPs Common Effluent Treatment Plants are based on PPP which is Polluters Pay Policy. Whoever is generating pollution will have to pay for that one. Here we have seen that based on the quality and quantity we have to proportionate the financial burden.

How can we find out the quality? The term used for the load of industrial wastewater is population equivalent so we know the total waste whatever is coming into the system so we will be converting it into population equivalents. We know that what is the waste generated by a single person whenever we talk about the municipal wastewater treatment plants and so on so industrial waste also will be converted in population equivalents so based on that one we can charge the industries.

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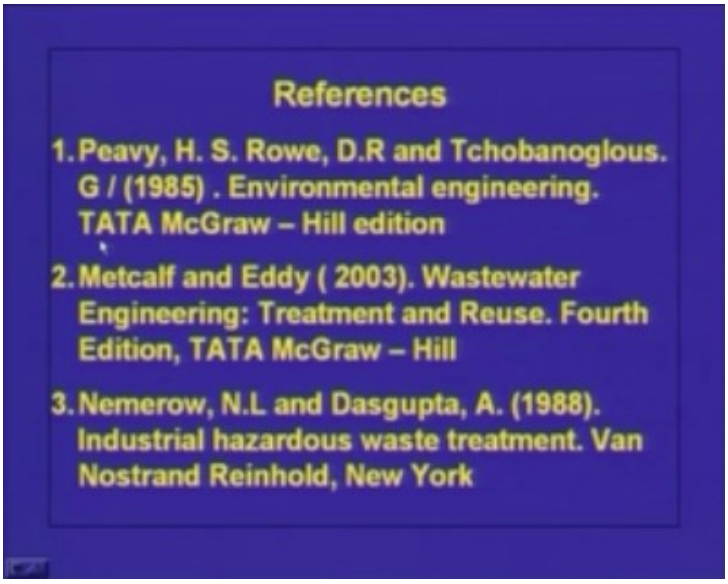

Now we will see what all are the reference books we have used for this course.
One is Peavy, H. S. Rowe and Tchobanoglous. This is environmental engineering, TATA McGraw - Hill edition.

Second one is Metcalf and Eddy, Wastewater Engineering, treatment and reuse.
So this will be giving you the details about the wastewater treatment process and this will give overall picture of environmental engineering that means water, wastewater etc.

Nemerow, N.L and Dasgupta, A is industrial hazardous wastewater treatment.
So whatever I was talking in the last few classes is covered in this textbook and another one is Fair Geer and Okun Water and Wastewater Engineering so this is very useful for water treatment and another one is Weber Physiochemical processes for water quality control, this is John Wiley and Sons publication. This will be giving you the details of the process mechanism, each and every process involved, what are the physiochemical processes, whatever we are using in water and wastewater treatment. It gives a good picture about the process mechanisms or the concepts. Another one is Manual on Water Supply and Treatment, Ministry of Urban Development, New Delhi.

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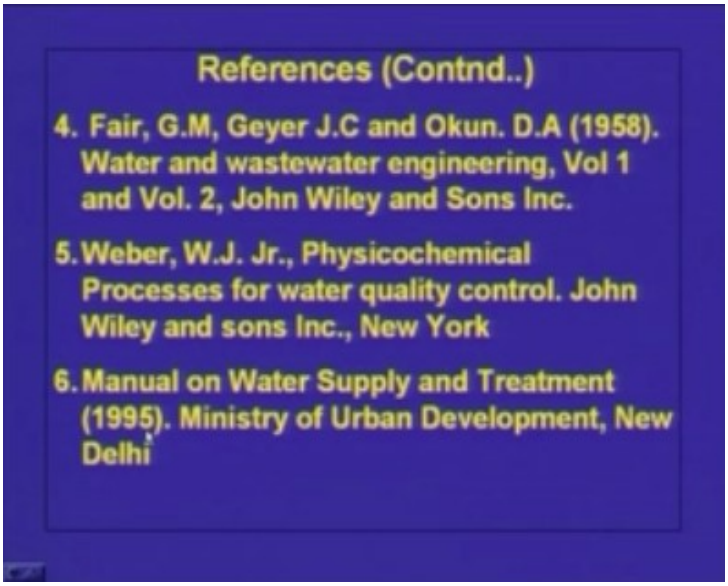

This manual gives you water distribution network designs and water treatments unit designs and all related aspects of water supply and treatment. It is good for design purposes.

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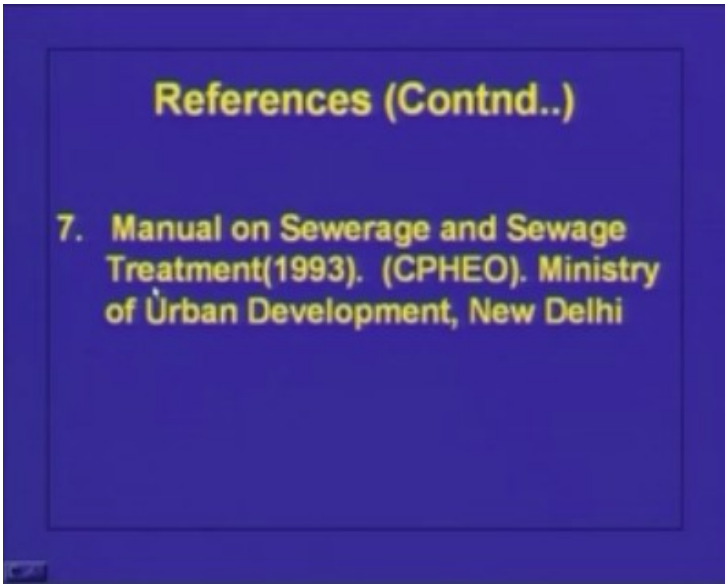

And the other one is Manual on Sewerage and Sewage Treatment, this is also Ministry of Urban Development, New Delhi. This gives you the details of sewerage systems and sewage treatment plants design.