Course Name: Industrial Wastewater Treatment

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Week – 09

Lecture 2: Treatment of wastewater produced from Textile and Dye and Fertilizers

So, welcome back. We are in module 9, lecture 2 and we are discussing the treatment of wastewater produced from textile and dye as well as the fertilizer industries. So, the topics that we will be covering during this lecture will be on woolen textile mills wastes. So, for example, we have already seen the processes and the wastewater generation in the cotton textile mills. So, today we will be discussing about the woolen textile mills wastewater. We will talk about the composition of a typical woolen textile mill wastewater.

We will also talk about the effects of the cotton textile and wool textile mill waste on the receiving streams or the sewers. We will talk about the treatment of the cotton and woolen textile mill wastes and lastly, we will discuss about the synthesis of a synthetic fabric. So, the woolen textile mills use wool as a raw material and wool basically comes from the sheep. So, this wool basically may contain number of impurities which may be organic in nature, which may be inorganic in nature, and it needs to be properly washed and properly scoured so that these materials which are there on the woolen raw wool, so this may be removed. That's why we use a number of processes here. For example, we use the scouring process as we use in case of the cotton textile mills also. Here we use another process which is called carbonizing. After the carbonizing of the wool, we go for the bleaching process. After bleaching, we go for the dyeing process and here it is very important that we go for an oiling and fulling process so that the wool that is obtained, so that basically may have a luster on it and that may basically have certain oil absorbed by the wool.

So, these processes are there and lastly, we go for the finishing operations where we take and try to make the woolen textiles out of the wool that we have produced. So, the impurities in the raw wool, it may consist of grease, it may contain foreign matters or other inorganic and organic materials which has to be removed by the scouring. So, scouring here in the woolen textiles, we generally perform it in hot detergent alkali solutions as well as the organic solvents. So, these organic solvents or the hot detergent alkali solutions, so they can dissolve the grease that is there on the woolen material on the raw wool as well as it will also remove the number of organic and inorganic impurities which are there on the raw wool. So, this may be recovered from the scouring waste.

So, the scouring waste may contain the grease that has been removed from the wool. So, this may be removed by the process of centrifugation or coagulation or flocculation and

then this grease may be used for the production of lanolin or potash. So, carbonizing is the process which is done after the scouring process and in the carbonizing process, we generally use hot concentrated acids so that whatever the vegetable matters or the organic matter, which is there on the wool, which is attached to the wool, so they may be converted to the charged particles. So, they these particles are charged and they become loose, and these loose charged particles later on can be removed from the wool by process of the mechanical dusting. So, wool may be dyed at any stage either we can dye the raw stock also, we can also dye it after the spinning and the weaving process also.

So, in oiling we generally go for treating the wool that has been obtained from the carbonizing process by using olive mill oil or we can use bark oil mineral oil mixture. So, this is spread over the wool so that the wool may become easily a spinnable, and this supports the spinning process further. And pulling is a process which converts the loosely woven wool that is there so it can be shrunk into a tightly woven cloth. So, that process is known as the pulling process. And the excess pulling chemicals or the oils, so they are washed out and of the fabric later on after the fabric is completed and then basically this finishes the operations of the woolen fabric.

So, the waste that is coming from dyeing and finishing process, so it is contributed mainly by the spent liquids which is there and the washing of the wool after the bleaching, dyeing and finishing process so that leads to the generation of the wastewater from the woolen textile mills. So, if we see the composition of a typical woolen textile mill wastewater so we find here that the pH may be 9 to 10.5 so this means that the wastewater is alkaline in nature, so the alkalinity is also nearly 600 milligrams per liter as calcium carbonate. So, BOD here may be higher that is it is nearly 900 milligrams per liter. The suspended solids may be around 100 milligrams per liter, and we see that the total solids may be around 3000 milligrams per liter which means that the dissolved solids have a higher fraction in the total solids.

The color may be nearly brown for the wastewater, and we also find the chromium that may come out during the dyeing process so this chromium may be nearly 4 milligrams per liter as we have also seen in case of the cotton textile mills. So, there can be number of impacts of the cotton and woolen textile mill wastewater if it is discharged into the stream without any treatment. So, this wastewater as it contains high BOD values so it may lead to the depletion of the dissolved oxygen in the streams. Similarly, there can be settlement of number of suspended substances which are present in the wastewater and the subsequent decomposition of these deposited sludge or the suspended material so it may result in the anaerobic condition it may lead to the depletion of the dissolved oxygen because of the degradation process. And similarly the alkalinity is there and the toxic substances like we are having sulfides here chromium here they may affect the aquatic life and these substances for the alkalinity as well as the sulfides and chromium may also interfere with the biological treatment process and the dyes which we use for the coloring of the woolen

material so they may also be toxic so they can lead to the adverse impacts on the aquatic life.

So, whatever the color is produced from the wastewater if we are discharging this wastewater into the streams directly so it may make the water unfit for number of uses for example it may make the water unfit for the industrial purposes it may also make the water unfit for the domestic purposes also. So there are certain industries which use water for example we can have dairy industry or the food processing industry so if the color is present there so it may impact its quality so that is why it becomes unfit for such type of industrial processes and that is why we try to remove the color before we discharge the waste water which is generated from the cotton and woolen textile mills into the streams. So, the presence of sulfides also makes this wastewater corrosive it can cause corrosion to the concrete structures and azo dyes as we have discussed earlier also so it can have a serious environmental impact as these azo dyes basically may result in the degradation by product like aromatic amines can be produced from the degradation of this azo dyes and this aromatic amine is highly carcinogenic in nature. So if we talk about the treatment of the cotton and woolen textile mills waste water so here the reduction of the waste and the strength through the process of chemical substitution chemical and grease recovery and recycling of water is very important step for example here we see that the desizing waste water so this may be passed through the ultra-filtration and the water which is basically filtered so this may be reused here for this process and similarly the concentrate which is there so that may be taken for the further treatment. Similarly, the waste generated from the moisturization and bleaching section it can be treated by using electrolysis process where the recovery of NaOH can be performed and whatever the wastewater is left after the recovery of the NaOH so this may be taken for the further treatment.

Similarly the drying process also may be taken to the treatment and here we use a treatment like electrochemical treatment we can recover a number of process chemicals as well as the waste water the VOD and COD values can also be reduced and further after the electrochemical treatment the waste water may be passed through the activated carbon or it may also pass through the resin or removing certain specific compounds from here and then basically this water may be reused for the further industrial purposes or otherwise the water can also be after the electrochemical treatment the water may be taken to the evaporator after which the water basically can be reused for the various industrial processes. So after recovery and the reuse of the waste water so we can also go for the process of coagulation and flocculation where we try to eliminate the organic substances so these chemicals have no effect on the elimination of the soluble dye stuffs so when we are going for the coagulation flocculation process so the soluble dyes which are there so they may not be removed by the coagulation flocculation process but the insoluble dyes so they may be effectively removed by using the coagulation flocculation process. However, the sludge that is generated so the cost may be a one of the important factors for the how

to handle and basically dispose of the sludge because there are lot of restrictions concerning the disposal of the sludge which is generated from the coagulation flocculation process. Similarly, adsorption can also be used for the treatment of cotton and woolen textile mills so here the activated carbon may be used but if we are treating the wastewater without pre-treatment, it can rapidly clog the filter of the activated carbon and that may increase the cost of the treatment. However, the use of the adsorption may be feasible when we are using it in combination with flocculation or decantation treatment or basically biological treatment so in that case the treatment by using adsorption by using activated carbon may be feasible.

So, we can have this combination so this combination leads to the removal of suspended solids the organic substances as well as there can be slight reduction in the color also but we have to see that the cost of the activated carbon may be high so again the economics of the treatment of the waste water needs to be considered before we go for the adsorption process. We can also go for methods like electrochemical methods which are more efficient than other treatment methods so electrochemical technology may effectively remove the acids which are there in the waste water as well as it can also remove a number of dyes like dispersed and metal complex dyes can be removed by the electrochemical technology and one of the advantage of this technology is that the sludge formation is minimal or is absent so that basically will lead to the lower load on the sludge handling and management. So recovery of the metals of the chemicals can be easily carried out when we are going for the electrochemical methods so electro coagulation can also be used for the treatment of the cotton and woolen textile mills so it can lead to the removal of color and TOC even if the pH of the waste water is high and the coagulants which are generated by this electrochemical method so they are generated in the aqueous phase and these coagulants which are generated so they can lead to the adsorption of the soluble as well as the colloidal particles which are there in the waste water and then later on they can be removed by the sedimentation process. And this electro coagulation process that efficiency of the electro coagulation process will depend upon the current density as well as the duration of the reaction and under the optimum conditions it has been found that nearly 90 to 95 percent of color and nearly 30 to 36 percent of the COD removal can be achieved. So, we can also go for the membrane processes for the treatment of cotton and woolen textile mill waste where we can use reverse process so it has been found that RO process can lead to the decoloration as well as the elimination of certain chemicals that we use during the process of the manufacture of the cotton and woolen textile mills so it can be done in a single step.

So, here it can remove number of mineral salts, the reactive dyes as well as the chemicals that we use during the process. But if we are having a higher tedious value in the wastewater so it may lead to the higher osmotic pressure generation and this may require a high energy for the membrane processes. So, this leads to the increased cost if we are having a high tedious wastewater being treated by the membrane process and the efficiency of the

treatment or we can say the economics of the treatment basically goes down. But the effluent that is produced by this process so this may produce a very high-quality effluent which can be reused for the for different industrial processes. In the membrane process we can also go for the nano filtration where we can try a combination of adsorption as well as the nano filtration so that we can treat the textile dye effluents.

So, this sequence basically decreases the load on the membrane because the adsorption may first of all remove high amount of dye and other organic materials so this will also lead to the decline in the tedious values also. So, this may lead to the lower load on the membrane, and this may increase the output of the process also. So nano filtration can remove number of lower molecular weight organic compounds, it can remove divalent ions, it can remove large mono valent ions, it can also remove the hydrolyzed reactive dyes, and it can also remove the other chemical auxiliaries that we use during the process. However, a major problem for these membrane processes may be that is the discharging of the concentrate into wastewater streams may be very very difficult and we have to again look for a certain feasible method by which we can treat this concentrate and then later on we can go to the safe discharge in the wastewater streams. The ultra filtration and the micro filtration may also be used which enables the elimination of the large molecules and particles and it may also lead to the elimination of dyes, but the elimination of dyes may be quite minimal for example here the elimination of dyes may be between 31 to 76 percent.

However, we can use the micro filtration and the ultra filtration as a pretreatment method before the nano filtration and RO process. So, after the recovery and the removal of the color may be done so by the processes that we have discussed just now so then we can go for the segregation, equalization, neutralization, chemical precipitation, chemical oxidation and later on to the biological oxidation. So, here several chemicals are used so that can reduce the BOD load by chemical oxidation method only for example we can use alum, ferrous sulfate, ferric sulfate, ferric chloride etc. so that the BOD load may be reduced, and the calcium chloride is also found to be effective in treating the wool scouring waste that is produced from the woolen textile mills. So then we can resort to biological methods so before the biological methods are employed we may go for the equalization, neutralization and chemical oxidation process and the composite waste which is now free from the toxic substances so it may be treated as efficiently as the domestic sewage because it contains sufficient amount of nitrogen as well as phosphorus so that is why it may be treated just like the domestic wastewater because it contains high nutrients and the toxic substances which are there in the wastewater so that have been removed in the earlier processes.

However, pH adjustment may be required to be done. So, we can go for the processes like trickling filters, we can also use activated starch process, we can also use waste stabilization ponds and that has been found that the treatment of the textile mill wastewater can be effectively treated by using these processes. So, it has also been found that the extended aeration process can also lead to excellent results in treating the strong

wastewater, so which eliminates the necessity of the sludge digestion as well. So here the activated starch process can eliminate the oxidizable substances up to around 90% but because of the low biodegradability the biological treatment by ASP does not always have a great success. So however, we can use bentonite clay or activated carbon in the biological system so that they can eliminate the non-biodegradable substances or the substances which are toxic to the microorganisms which are produced by the textile industries before we go for the biological process of the treatment.

So, we will see here that the flow diagram for the treatment of the cotton textile mill waste is shown here where we see that the raw wastewater it first of all enters the equalization tank. After the equalization tank we may take the wastewater to a neutralization tank where sulfuric acid may be added so that the wastewater may be neutralized. Later on the coagulant may be added and it is taken to the coagulation tank where the suspended solids as well as the colloidal solids as well as some dye basically also can be removed from the system by the coagulation flocculation process and later on it is taken to a settling tank where the floc that are generated from the coagulation flocculation tank so they may be settled down and the sludge that is generated from here may be taken to the sludge drying beds for the disposal. After the primary sedimentation tank, we take the wastewater to the trickling filter for example here we can use trickling filter, and this trickling filter is a high rate trickling filter. So, after the trickling filter we take the wastewater to the secondary settling tank where the sludge basically settled down and the sludge that is generated so it may be again taken to the sludge drying bed for the further disposal.

The secondary effluent may again be recycled here to the trickling filters because the trickling filters they are high rate trickling filters so this recycling may be done so that the efficiency of the treatment by the trickling filter so this may be improved and after which the waste water can be safely discharged to the environment. Similarly, we can see here that this figure shows the flow diagram for the treatment of the woolen textile mills waste water. So the raw waste water from the woolen textile mills so it enters in the grid chamber first of all so that the particles which are heavier in nature so they may be removed from the waste water and because woolen textile waste water may contain lot of grease and oil so here the grease recovery tank is installed so that the grease may be recovered by the process that we discussed earlier and then basically it can be mixed with the other waste and here we can take it to the equalization tank. After the equalization tank we add certain coagulants to it so we take it to the coagulation tank where the coagulation population for the removal of the suspended solids as well as the colloidal solids and after which we take it to the primary sedimentation tank and here also we can use a high rate trickling filter after treatment by high rate trickling filter we can take the waste water to the secondary settling tank and here the effluent generated from the secondary settling tank may be recycled so that the efficiency of the treatment may increase and here the sludge that is generated from the secondary settling tank as well as the primary sedimentation tank so it

may be taken to a digester and after the digesters basically it may be taken to the sludge drying pads and the effluent from the digester may be again mixed with the waste water which is coming out after the grease recovery tank. So now we will discuss the synthetic textile mill wastewater.

So, the synthetic textile mill waste water is generated from the synthesis of the synthetic fibers and the manufacturing of the synthetic fibers may involve basically two steps. One is the manufacture of the synthetic fiber and this synthetic fiber may be produced from the chemicals by using certain chemicals so that the synthetic fibers can be produced so it is of purely chemical in nature these synthetic fibers and similarly after the preparation of the synthetic fibers we go for the preparation of the cloths so here we can have these two processes taking place so these two processes may be done in a single plant so it may be known as the integrated plant where basically we can have the manufacturing of the synthetic fibers as well as manufacturing of the cloth also. Or otherwise, we can also go for a separate plant where the manufacturing of the synthetic fiber may be carried out in a separate plant and the manufacturing of the cloth may be taken out in a different plant. So, the wastewater that is generated from the manufacturing of the synthetic fibers so it will depend upon the type of the raw material that we are using and the processes that we are adopting in the manufacturing of the synthetic textile fabrics. So here the synthetic yarns are essentially they are composed of pure chemical compounds so that's why it may require a very light scouring or it may also require a very very small amount of scouring to be done because the synthetic yarns so they are already having a capacity to absorb the chemicals to absorb the dyes which we are using in the later processes and as well as to absorb the processes that we use for the finishing of the cloths.

So that's why the synthetic yarns may require a very little scouring process is involved during the processing of the synthetic yarns. And the synthetic yarns and processing as well as the cloth making may also be carried out on the conventional machinery as we have seen in the previous examples where we are going for the cotton textiles or the woolen textile preparation. So, whatever the machinery that are used in during the preparation of the cotton textile as well as the woolen textile so the similar machineries are used in the preparation of the synthetic textiles. So now let us discuss about the flow diagram of the manufacture of the nylon-6. So, this nylon 6 is produced from organic compound that is called the caprolactam.

So, here the first process that we use here is basically called the polymerization of the caprolactam. So, the monomers of the caprolactam may be taken may be polymerized and then these polymers may be used for the preparation of the fibers. So, for example here we take the feed which contains the caprolactam into it we try to take it to a melter here so the caprolactam that we use is melted first of all and so it is basically converted to the monomer and this monomer may be stored in a tank which is known as the monomer storage tank. So, after the monomerization has been done so then we take it for the polymerization. So,

we will take it to a pre-polymerizer tank where basically the pre-polymerization process for the caprolactam takes place and later on we take this pre-polymerized caprolactam into the polymerization column where the polymerization of the caprolactam is achieved.

After the polymerization of the caprolactam is achieved we take this polymerized caprolactam to a pelletizer. So, we can take it first of all to a Quench trough and later on we can take it to a pelletizer. So, this the pellets of the caprolactams are made and these pellets are used for the further processing. For example, here these pellets or the chips basically may be formed and these chips or the pellets so they may be used for the manufacture of the synthetic fibers. So here after the palletization process is over so we take the caprolactam to the extractor first of all and then we take it to a wet chip hopper where these chips basically they are wet in nature so they are stored here after the extraction process and then basically we take it to a dryer where the chips which we have formed so they are dried for the further processing.

And then we take it to a dry chip hopper and from the dry chip hopper this is taken to a extruder where the polymerized caprolactam is remelted and then from the remelted caprolactam the extruder basically extrudes the threads of the caprolactam. And so here we take it to a spinner where these threads may be spinned up and then basically we take it to a take up and then we take this to a draw twister and from the draw twisters we go for the processes of extracting of the caprolactam fibers. These caprolactam fibers may be made for making of the yarn from here and this yarn is known as the nylon-6. So, that is how the synthetic yarn basically can be made, and this synthetic yarn may be used for the further manufacturing of the cloth. For example, the nylon 6 can be used for preparation of a number of synthetic cloths here.

So, this process is mainly for the manufacture of the synthetic fibers and these synthetic fibers may be again taken to the further processing where we try to use the process like for example, the finishing processes for example, we can go for the scouring process though the scouring may be required in a very small amount and after the scouring process we may take it to the process of the dyeing and after the dyeing process we can take it for the finishing process and then later on we can go for the weaving process. So, these processes that we use here, so they are similar to that of the processes we use in case of the cotton as well as the woolen textile mills. So, these processes we will be discussing that how these processes, what are the wastewater that will be generated from these processes. So, that we will be discussing in the coming lecture. We will be discussing about the wastewater that is generated from the synthesis of the synthetic fibers and the wastewater that is generated from the finishing processes like for example, the scouring process, the dyeing process.

So, that is similar to that of the cotton and textile mills. So, we will discuss that separately and we have already discussed that. So, that is why we will not discuss it in detail, but we will try to discuss the treatment of the wastewater that is generated from the manufacture

of the nylon-6 fibers. So, we stop here, and we will be discussing further the viscose rayon processes in the coming lecture, and we will also be discussing about the waste water treatment that will be generated from the manufacture of the synthetic fibers in the coming lectures. So, these are the references that we have used for the preparation of this lecture.

So, thank you.