Course Name: Industrial Wastewater Treatment

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Week – 12

Lecture 60: Mine Wastewater including Acid Mine Drainage and Industrial Complexing for Zero Pollution Attainment

Welcome you all. Today I am going to deliver lecture 5 of module 12 which is on mine wastewater including acid mine drainage and industrial complexing for attainment of zero pollution.

So under this we are going to cover some case studies on industrial complexing like we have cement industry and we have fertilizer industry. So how these industries together they can make a complex in order to utilize individuals waste into the process and the operation so as to get the overall implementation of zero waste discharge. And then we have multi-industrial cluster where we have covered like a number of industries like sugar industries and distilleries, cement industries, fertilizer industries together number of industries in the form of a clusters. If they are located how the industrial complexing for the management of raw material and resources along with waste generated from individual industries how they can be managed and then we will be looking about the wastewater which are generated from different industries and how to go for a common effluent treatment plant system to overall reduce the cost of the treatment as well as a lot of other benefits associated with the design of common effluent treatment plant for a cluster of industries and if we will see, we will also go through the objective and what are the various approaches that are used for designing of common effluent treatment plant and then finally we will be going through the description and various unit operations which are involved in the common effluent treatment plant their objectives and the overall efficiency.

So now let us talk about example of cement and fertilizer industries where this industrial complexing has to be carried out. So. here if we see that is basically the cement plant and say if this is the phosphate fertilizer plants so here basically if we see from the cement plant what are the raw material that is required that is the gypsum, this is the sand and here this gypsum and sand that is used here as a raw material to produce the cement where this cement whatever is produced that is sold in the market to the construction industries and in the process if we see lot of air pollution is generated like sulfur dioxide and then this dust is generated and whatever sulfur dioxide that is generated basically that is again is taken to the another process which is scrubbing process and after scrubbing of this gases which are present in the flue gas so they are basically scrubbed and converted into H_2SO_4 acids and this acid can be used as a raw material in the H_2SO_4 plant or after scrubbing this SO_2 after removal of other impurities can be used as a raw material for production of sulfuric acid in the H_2SO_4 plant which along with this hot water basically helps in production of this H_2SO_4 that basically is used as a raw material for phosphate fertilizer plant. So, the waste which is like generated sulfur dioxide after scrubbing this sulfur dioxide is used as a

raw material in H_2SO_4 generation plant and this converts into H_2SO_4 acid and that is basically then used as a raw material in another industry that is the fertilizer industry similarly if we see another waste which is generated from this cement plant that is the dust so this dust after the removal of filters. So, this can be used as a soil fertilizer for safe agricultural industries so this waste is again used in the industries for soil remediation process. So, whatever the raw material required for this most of this like sand and gypsum we are getting from the fertilizer plants and whatever the waste that is being generated that is used either in the agriculture and then as a raw material for generation of H_2SO_4 in the fertilizer plants and similarly if we see analysis of raw material in the products for the phosphate fertilizer industry so here if we see the basic raw material that is the calcium phosphate rock is the raw material and this is the H_2SO_4 which is required for production of this fertilizer, so this fertilizer after these two raw materials are used in the fertilizer plant so that generates gypsum so this gypsum is again used in the cement industry as a raw material and then whatever this H_3PO_4 or P_2O_5 that is used as a fertilizer for agricultural industry. And similarly if we see the waste, so whatever the waste that is generated from this fertilizer industry that is HF for the water treatment process that is used in the municipality for the treatment of the water and then whatever the solid waste that is coming from the municipalities that is used in the composter and whatever this organic waste that is converted into the nutrients and this organic solids or nutrients produced then it is used in the again industrial operations industrial activities as a fertilizer so these are like the type of material and process flow diagram which basically indicates the different aspects of industrial complexing within cement and fertilizer industries.

And then this is like the example of industry complexing within the sugar alcohol pulp and paper industries fertilizer industries cement industries. So, if all these industries you see they are located within the close proximity they can also establish the industrial complexing process. So, let us start with sugar industry so here if we see this is the sugar industry which basically requires sugarcane as a raw material. So, this sugarcane comes from basically the agricultural field, so in the form of sugar cane and then it is transported to in the form of sugarcane to the sugar industries or sugar refineries so they basically generate the sugar after processing of this sugarcane and then this results the bagasse as a waste in the sugar industries and another byproduct that is molasses which is generated from the sugar cane industry that is used as a raw material where this molasses is fermented to produce the alcohol so this based from the sugar industry that is the molasses is used here in the alcohol industries or distilleries to convert into alcohol and then this alcohol basically whatever is again generated from this is sold as a product in the market and then rest of the alcohol that is also used in a fertilizer plant for production of this fertilizers. So, this fertilizer industry basically produces different compounds in the form of fertilizer of nitrogen and phosphorus compounds so here similarly if we see the bagasse which is basically generated from sugar industry that is used as a raw material in the pulp and paper industries so this industry basically generates these pulps using whatever the bagasse which is generated from sugar industry which is then goes to the paper mills where from this paper is generated as a product from this paper mills and the waste which is generated from this pulp and paper mill that is basically recycled so that is basically the major liquid waste that is generated is a black liquor where from this NaOH recovery is to be carried out and this NaOH after being recovered will be recycled here again in the pulp and paper plant for recycle and reuse and whatever this recovered

NaOH that is produced from the process that can again be used in the cement plant as a raw material. So, these are like different modes of collaborating within the neighborhood industries in order to implement this the concept of industrial complexing.

So, now let us talk about the various impacts of industrial complexing. So, these basically these two triangles one is upward triangle another is downward triangle so here what we can see one indicates the increase and another indicates the reduce or decrease, so here if we jobs are increasing because of this industrial complexing will have different responsibilities will require different manual power, so this ultimately enhances the job prospects in the industries then also it enhances the production level so the sales is increased and then know how is increased innovation implemented and the new business strategies are formed similarly inward investment result into better profit and then the knowledge transfer and utilization of assets so these are the number of parameters which enhances because of the industrial complexing and what ultimately results in to reduce that is the requirement of our resource that is reduced, requirement of water is reduced, generation of hazardous waste is reduced, emissions in the form of air emissions like carbon dioxide transportation cost is reduced, environmental pollution is reduced and landfilling and associated cost and risk that is all is basically reduced. So, if we see we are in the win-win position by adopting the industrial complexes one way it enhances the jobs production the learning innovation and opportunities for sustainable management of resource and on the other hand it basically reduces the requirement of raw material, requirement of water and also minimize the waste and the environmental pollution problem. So, this is a kind of green initiatives so that industry and industry players that should think of and adopt into the process in order to have overall economy and sustainability of the production process.

So, now let us talk about the brief introduction on the common effluent treatment plant. So, here if we see these common effluent treatment plant they are basically designed for treating the effluent that is being generated from number of industrial units which are located within the proximity so as to collect their wastewater together and a common place they are we can have the treatment system whereas all the wastewater they are brought together to the treatment plant and they can be treated and disposed as per the environmental regulations. So, this basically reduces the overall treatment cost which is required for treatment of industrial effluent generated from a group of industries instead of individual industry so there will be a lot of cost saving and also if we see this common effluent treatment plant for the industries that is basically in tune with the municipal corporations of bigger cities where they are combining municipal wastewater sewage from all individual houses bringing it to a common place and then having a large sewage treatment plant for their treatment and final disposal. So, this basically the concept of common effluent treatment plant that is very effective to achieve the environmental norms or the guidelines prescribed by various regulatory agencies like state pollution control board, central pollution control board and as per the Environmental Protection Act. So, in terms of basically wastewater discharge these are like Ph, BOD, COD, these are the parameters which are looked into before the treated wastewater that has to be discharged so as to comply with the environmental discharge standard.

Let us see the what are the major objectives of this common effluent treatment plant so as we discussed let us to reduce the overall cost of the treatment for the combined effluent generated

from nearby industrial complexes or the unit operations or the processes and then it also has the possibility of recovery and recycling of the important ingredients or metals which are precious metals present into the wastewater, so we have the option for recovery and recycling of the valuable metals present into the wastewater which is not basically exercise normally because of adopting the overall economy in the small-scale industrial setup. So, it is also possible to reduce the space required for the treatment of wastewater construction and implementation of individual treatment plans for individual industry so together if we plan and implement the common effluent treatment plan for a group of industry, so we will be able to reduce more than 50% of the space that is required for individual industries and hence to minimize also the requirement of technically staffs expertise trained personnel for operation and maintenance of individual ETPs. So, the basic objective of this common effluent treatment plant that if we see that is homogenization of wastewater that is generated from heterogeneous industrial clusters. So, this basically homogenize the industrious wastewater generated from different industries make it a uniform and then they are basically generated from diverse industrial setup operations and the process and brought to a common platform for their treatment and disposal. And this concept also helps in reducing the problem of monitoring by the regulatory agency because they have to visit to a common place where they can see the performance and environmental compliance adopted by the particular industries and also it helps into the organizing the disposal of treated effluent and the solid sludge that is semi solid sludge which is generated from the common effluent treatment plant.

So let us see the sources and major contaminants which are normally found in the wastewater generated from different industries. So, if we see a complex organic chemical industry, so it may generate pesticides, pharmaceuticals, paints, dye, petrochemical so many environmental pollutants. And then if we talk about like thermal power plants so they may generate lot of heavy metals in the form of lead mercury, cadmium, chromium, arsenic and together with this they may also generate lot of fly ash which further require a lot of space for its disposal and storage. And then if we talk about the iron and steel industries, so they have a lot of ammonia, cyanide, phenol, naphthalene so there are many toxic pollutants they are generated from iron and steel industries. Similarly, if we see the pulp and paper industries they may have chloroform dioxins furans many apart from the other organic matters. So, if we see a combined a plant generated from these industries when they are mixed, so it contains a variety of compounds pollutants which needs careful observation and analysis. So as to plan a proper treatment system a combined treatment system to meet with the environmental discharge norms of all these industries.

Let us see what are the approaches for designing and planning of a common effluent treatment plant for a group of industries. So, first of all we go for quantification of the wastewater basically which is generated from individual industries and then this characterization that is basically very-very important because this gives us an idea of the amount and what type of pollutants they are majority in the wastewater and what are the available treatment system to be planned for their removal. So, after this when all this wastewater is equalized in a equalization tank what will be its equalized concentration of different pollutants present in the wastewater. So this is all has to be established before planning to the design of a common effluent treatment plant and then after establishing this inlet feedwater quality that is going to be treated in the common effluent treatment plant we have number of treatability options technology where there are biological

treatment system, advanced treatment system, tertiary treatment system, so under this treatment system there are again number of options to select that particular type of unit that has to be utilized for a given quality of the wastewater. So, this we will look into the various process which are used for removal of particular pollutant and accordingly we decide the unit operations like what are different geochemical units, chemical treatment system, biological treatment system and then what type of tertiary treatment system because when we design for the common effluent treatment plant all these components and units they are desired in order to meet with the environmental discharge standards. And then we also look into the mode of disposal of the treated effluent so as to arrive at the environmental discharge standard for a particular mode and then as I said there will be a lot of semi-solid sludge that will be generated from the sedimentation tank, primary clarifier, secondary clarifier, biological treatment process so all this sludge that has to be collected and then sludge has to be treated before its disposal so there are again number of treatment system available for the treatment of the sludge aerobic digestion of the sludge, anaerobic digestion of the sludge and then there are chemical treatment process also. So, we have to look into the final disposal and treatment of the sludge and then finally we have to see if there are any precious metals they are present what are the advanced treatment processes that can be used for their recovery and recycle and reuse.

So, these are basically the various treatment process the flow diagrams which has to be selected for designing a common treatment plant. So, here if we see these are the preliminary treatment process, then primary treatment process, then secondary treatment process and advanced treatment process. So, under each treatment system there are number of options that has to be selected like for preliminary treatment system this is mostly designed for removal of floating impurities sand and silk particles which are present, so design of this and selection of screens which are required depending upon the quality of the water that has to be selected and then we have to go for the primary treatment system so primary treatment system basically involves the removal of suspended solids which is carried out by designing the sedimentation tank, so this sedimentation tank that is used to remove out the settleable suspended solids which are present in the wastewater. And then after this primary sedimentation tank the wastewater goes to the secondary treatment system when all the inorganic suspended impurities they are removed from the wastewater, so that goes for secondary treatment system here again if we see these are basically the biological treatment system which are used for removal of dissolved organic contaminants present into the wastewater. So, again under this we have two types of system one is low rate process another is high rate system, so low rate process basically that involves the stabilization ponds, aerated lagoons, wetland systems and then high rate process that basically involves the activated sludge trickling filters and rotating biological contractors. So, these are the biological treatment process low rate process high rate process and depending upon the concentration of the organic matter concentration of BOD and COD we have to decide whether the low rate process or the high rate process that would be convenient for this common effluent treatment plant. So, accordingly we have to select it and then basically in this process what happens all their organic matters which are biodegradable in natures so they are basically digested they are removed from the wastewater and after this wastewater there are still certain contaminants which are not removed like if there may be nitrogen, there may be phosphorus there may be very fine suspended particulate matters which are not yet removed and then again there

may be particular priority organic pollutants which are not removed which are recalcitrant type of organics which are not removed by this secondary primary and preliminary treatment process so they are basically targeted under advanced treatment system. And then here you can see in the advanced treatment system for removal of nitrogen we have a conventional treatment system that is nitrification denitrification process then we have like selective ion exchange process for removal of nitrogen nowadays there are anammox process that has been discovered which directly convert this ammoniacal nitrogen in the form of dinitrogen nitrogen gas which is discharged and this is again there are a scrubbing process for removal of this ammoniacal nitrogen, so ammonia slippers they are also designed as a unit operations for removal of this ammonia. So, there are for different pollutants again there are various alternatives according to the concentration and nitrogen the form of nitrogen it is present in the wastewater we have to make a selection of the advanced treatment process for nitrogen removal similarly if there is a phosphorus so we have to use this chemical precipitation process for removal of phosphorus and accordingly if there are very fine suspended particulate matter which are not removed very fine collides are present then we have to go for coagulation flocculation process or maybe membrane process for their removal and then still after the treatment if there are dissolved solids they are present. So, for that again there are reverse osmosis system electro dialysis system and then that is distillation process so number of process they are there and finally this basically after removal of all these contaminants this wastewater that has that goes for the disinfection process and after disinfection this is discharged as a treated effluent where we have to check whether it meets with the environmental discharge standards as per IS 2490, so this is effluent disposal standards. And now let us talk about the sludge which are generated here from the primary sedimentation tank and the secondary sedimentation tank which are designed immediately after this biological treatment process that will be processed again. So, let us talk about the sludge which is produced from the primary sedimentation tank and secondary sedimentation tank which is designed immediately after the biological treatment system. So, here the two different types of sludge are produced like one is biological sludge and another is non biodegradable sludge so this this sludge goes here and this sludge goes here and they again for different type of sludge there are different unit operations different treatment systems which can be selected for the treatment and final disposal of the sludge. So, here again if we see that is thickeners are designed the sludge digesters are there dewatering using the filters and then centrifugation process are there sludge drying beds are there so accordingly we try to select the particular treatment system for management, treatment and disposal of sludge. So, this is basically the various options which we have to explore under different preliminary, primary, secondary and advanced treatment category and a final flow diagram has to be prepared in order to meet with the environmental discharge standard as per IS 2490.

And here if we see this is basically the description of the common effluent treatment processes. So, as I said under primary system screens are designed skimming tanks are designed equalization tanks are designed so basically screens they are designed for removal of the floating matters which are present in the wastewater, whereas this skimming tank if lot of highland grease is there so this skimming tanks helps in removal of this present in the wastewater then this is the equalization that basically equalize the flow and the concentration of incoming wastewater from different industrial units, so that acts as a buffer and make the front homogeneous by mixing and

here this also helps into making the pH in the neutralized range, so this helps in neutralization of the wastewater as well. So, these are like the different unit operations under different categories. Similarly for secondary treatments the system there are clarifiers there are aeration tank and then there is a balanced tank.

And then we can have number of tertiary treatment system like pressure sand filters activated carbon filters so this pressure sand filters basically used to reduce the BOD and COD and the bacterial present into the wastewater so these filters they are basically used to remove out the very fine size of biological organics or inorganic contaminants which are present so as to make the water free from the bacteria and also free from the organic matters. Similarly we have this activated carbon which basically absorbs various contaminants like nitrogen, in the form of ammonia like various heavy metals are there, some dyes are there so these colors are there so these are the unit which are adopted for removal of color any other metals which are present into the wastewater so these are the like polishing treatment system which are used to remove basically the color metals any order and make the water a very good quality so as to be used for further industrial operations.

So, this is basically the schematic layout of a common effluent treatment system. So, here we can see this is the wastewater which comes through the inlet and this is this passes first from the bar screens where all the floating impurities they are removed and then oil grease removal process where all the oil and grease which are present as a floating impurities they are removed from this oil and grease removal system, this can also be done by designing the skimming tanks oil and grease separators so number of systems are available for removal of this free oil and grease so we can select here. And then after this preliminary treatment then the wastewater that goes for equalization tank when the wastewater collected from different industries is uniformly mixed in order to make the wastewater uniform in terms of concentration and also in terms of flow and here also we can use this lime, alum, poly electrolyte to be used for neutralization of the wastewater and also they can be added as a coagulant here, so this can be used as a mixing basin here also if we again use chemical dosing system into the equalization tank along with the mixer which will mix all these chemical agents or coagulants which are used for removal of colloidal impurities present into the wastewater. So, after this coagulation and flocculation process that water goes into the primary clarifier where this flocculated water is taken for the gravity separation of the sludge that is being precipitated, so that sludge that is removed and clarified water that goes for activated sludge process which basically adopts aeration tank where the wastewater that is aerated here in order to carry out the aerobic oxidation by the aerobic group of microorganisms so they are basically take this organic matter as a substrate and convert into the carbon dioxide and water which is the final in products. So, all the organic matter they are finally converted into carbon dioxide so after this aeration tank the wastewater is taken out to a secondary clarifier because the treated effluent that contains lot of microbial impurities in the form of sludge so that is removed into the secondary clarifier. And then this is the secondary stage of this aeration tank and then the clarifier for removal of biological impurities and the biological sludge present in the treated effluent from the aeration tank too and then finally this entire treated water that is taken to a balanced tank where this entire water goes for the advance and tertiary treatment process where there is a pressure sand filters, so this pressure sand filters that is basically is used for removal of very fine colloidal impurities which could not be removed

in the earlier process so there is a layer of sand gravels so that basically helps into removal of this biological impurities bacteria and any other contaminants present into the wastewater. So, after this filtration of the wastewater this goes for the advanced treatment system that is activated carbon filters where all the taste order color all this kind of impurities which are not yet removed that is removed using this activated carbon column. So, this basically helps us bringing the high quality of treated effluent for many industrial uses.

So, these are the references.

Thank you