

Course Name: Industrial Wastewater Treatment

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Week – 12

Lecture 59: Mine Wastewater including Acid Mine Drainage and Industrial Complexing for Zero Pollution Attainment

Welcome you all. Today I am going to deliver lecture 4 of module 12, which is on mine-based water including acid mine drainage and industrial complexing for zero pollution attainment.

So under this we are going to cover the basic introduction about the industrial complexing, its objective, the principle behind this industrial complexing with an examples of an cement industry where the contribution of other industries, other resources contributing towards the raw materials that we will be describing here and then we will be also having discussion on the various drivers which promotes the industrial complexing phenomena and what are the various conditions that are required for industrial complexing. Then we will be also highlighting the various elements of industrial complexing. Then our discussion will follow the major issues and challenges which exist over this industrial complexing and then we will be also discussing upon the spatial scale of industrial complexing along with its impact.

So, here if we start with the basic introduction on the industrial complexing, so this means basically the industrial symbiosis between the neighborhood industries. So, industrial complexing basically is a process by virtue of which the waste or the by-product generated from one industries or different process that can become the raw material for another industry before the cycle starts again. So, this basically the industrial complexing means the process of attainment of zero discharge by using and converting the waste into by-products and into the products. So, the process basically involves the three basic features that is capture, recovery and reuse of previously discarded resources from one industrial operation by another industry. So, this is basically capturing the raw material for this what we require the information about the neighborhood industries, their by-products, their waste, their value, their composition so that the same can be stored and transported to another industrial complex for its use as a raw material for that industrial operation. And then that is another element that is called as the recovery. So, recovery means that recover out any valuable materials which are available in the waste which can be used as a raw material for another industry or the process or the operations. And then finally the by-products generated from the industries that can be reused and recycled for its sustainable use. So, this is basically the process of using, reutilizing the discarded resource from one industry by another industry. And basically this process traditionally takes place between the two or more industries operating in the close proximity because that transportation of raw materials or by-products from one industry to another industry that must be economized because if the transportation cost is high then this process of industrial complexing would not work and

would become the costlier option and hence that will not be implemented. So, transportation cost that plays a very important role. So, this complexing has to be carried out within the industrial premises located within the close proximity to each other. Then if we see the application of the concept basically this allows the resources to be used in a more sustainable way and hence to contribute to the creation of a circular economy.

So here this is an example like the various systems which are used in the industry like linear system and circular system and for attaining the sustainability in manufacturing and industrial operation this how this industrial complexing advances that can lead to the circular economy. So here if we take a normal industry which adopt the linear circular process where the natural resources they are brought to the industry and then this is processed within the industry and after processing the by-products and the products are generated. Along with these by-products there are also the waste are generated. So, products that are normally sold in the market for its utilization and uses but whatever the waste that is generated that is basically goes for disposal. So, this is a kind of linear system there whatever the waste that is generated is discarded without any further utilization without any further recovery and reuse of the materials important ingredients present into the waste. And then in the circular economy that is completely different process where the raw materials which are coming from the natural resources they are transported to the industry and then in the industry they are processed and after the process processing the products are generated which are sold into the market for its uses, whereas whatever the waste that is generated that is not discarded as a waste rather it is perceived as a resource and it is again recycled into the another nearby industry where this waste or the material present into the waste they are fit for used to be a raw material for another industrial operation. So, along with the another raw materials which are coming from the natural resources they are mixed with this waste and together this waste that is also processed within the same industrial operations and then this waste is basically after processing is converted in the form of reusable products and that reusable products are used further in the society for its various beneficial purposes and then whatever the raw material that is converted into the product that is also being used, so as such there is a net zero waste that is generated in this circular process. So that is basically adopting the concept of industrial complexing which ultimately bring the circular economy within the process and operation and results into the sustainable management of resources. So, these are the basic differences between the linear system and the circular systems which are used in the industries. So previously the industries they were going for this linear system but now because of having lot of advanced treatment technology, recovery and reuse technology the waste utilization technology. So, now we are adopting this circular economic system where the waste which is generated that is again used in the nearby industry as a raw material to generate again the reusable products which can further be reused and utilized.

So, this is an example of industrial complexing in a cement plant. So, here if we see that is like the cement plant the center point of the industrial complexing system where the materials and the waste generated from other industrial operations are processed, they are used as a raw material for sustainable management of waste and use of the waste as a resource. So, here if we see the cement plant they use lot of silica, so this silica can be generated from the construction and demolition industries, here they are also generated from the ceramic clay and sand production industry so this silica whatever is generated as a waste from this industry that is diverted to the

cement plant for use as a raw material and similarly here the iron and steel industry also they generate lot of milli scales, so that is also used as a source of iron which is required as a raw material for the cement plant so this this milli scale that is also used as a raw material and also from many other industries like foundries and filters cake and this catalytic filter cakes silica, alumina, road sweeping industries which are generated from local authorities and even some hazardous waste they are also used along with the sludge which comes from the filter cakes and the fly ash which are generated from the thermal power plants. So, these are the coal combustion residues which are generated from different thermal power plants. So, these are all the alternative raw materials that are available from different sources and they can be used as a raw material for cement plant by initiating the industrial complexing for the attainment of zero waste. So by this what we can get is like the a cement plant which has a production capacity of 12 million tons of cement and they require a lot of raw materials so out of this if we see that is around 1 million ton of raw material that is required for the production of 12 million ton of cement that can be generated by industrial complexing from different alternative raw materials available from ceramic industry, construction industries, iron and steel, thermal power plants using this coal combustion residues. So, nowadays there are a number of thermal power plants which are using the coal combustion residues the fly ash which is generated from the thermal power plants as a raw material to be used in a cement plant for production of cement. So, this ultimately benefit the industries in the two way one that is the waste which is generated is being utilized and converted into the resource so that basically attains into the zero discharge and aid into the circular economy of the system.

So, let us talk about what are the different drivers which are used in industrial complexing so that is basically the major driver that is diversity in the industries. So, in an industry of premises there must be variety of industries and those industries which are basically having industrial symbiosis where the waste generated from different industries various operations that can be utilized in another industry as a raw material for generation of reusable byproducts. And then geographic proximity as I discussed transportation is one of the important issues which incurs a lot of cost and makes the products costlier. So, for this industrial complexing basically the industries which are located they must be in the close proximity to the industry so that industrial complexing would not result into the transportation of raw material to a larger distance and that in turn will result into economy of the process while implementing the industrial complexing concept and then there must be a favorable legislation and the policy that the country should have a favorable legislation and policy for reuse and reutilization of just waste product from one industry to another industry and then there is a need also for like reduction of the raw material and the waste and their correlated cost. So, as I discussed if there is a scarcity of raw material that basically arises the need for industrial complexing, so that the raw material consumption of that industry can be decreased and similarly the waste utilization concept that should also be there so as to create an the need for the industrial complexing and then finally the cost which is ultimately depends upon the use of waste product into reusable products which basically reduces and makes the process economical.

So, this is basically the economic and financial incentives must also be provided by the government by having proper legislation and the policy for the waste utilization. So, if there are some benefits some incentives are given by the industry, so that will attract the industries the

smaller scale industries to make industrial complexing to adopt the industrial complexing phenomena and there are other factors as well other divers like availability of information about the industries and various industrial players which are active in the process of industrial complexing and who can deliver the information on the benefits of industrial complexing and what are the different resources that are available in the industry which can be used by another industries for its utilization and then the high cost of raw material and the waste treatment option that is also basically the major driver for industrial complexing because if the cost of the raw material is high then it will result into higher cost of the product and that will there affect their competition in the market so utilization of waste as a raw material that will ultimately reduce the overall cost of the raw material so that is one of the major driver that basically arise the need for industrial complexing. And also if we see the waste treatment options even if the waste are available but we don't have any sustainable technology for their utilization so this process and the concept of adopting the industrial complexing that would be defeated so there must be also advancement in the technology available for the use of one waste in by the another industries for their conversion as a product and then that is the last point that is the sustainability oriented mindset that is the ultimate requirement among the industrial players which are involved in the industrial complexing process so they should have this set of mind to have sustainable development and such oriented industry players may lead to the development and implementation of industrial complexing process.

Then let us talk about the conditions which are needed for adopting this industrial complexing process. So, that is basically the space peak legislation there must be the legislation and the policy made by the government which basically favors this industrial symbiosis practices to adopt the economy and a matching system basically a meeting place where the industry and the industry players the potential users they can meet for the discussion and meeting among these producers and the industry players and their potential users, so as to decide for the agreement between the two for adopting the measures to be taken for industrial complexing process and then the scarcity of the natural resources as a raw material so if raw materials are limited within the proximity of the industries and that will basically arise the need for the alternative raw materials which can attack the industry players to go and use for waste materials alternative raw materials available nearby proximity for their production process and then price of the raw materials as I said price is an important element which basically decides the adoption of industrial complexing process because of increase in the price of the raw material that basically favors the use of alternative raw materials which are available in the form of waste or nearby industries their byproducts to use as a raw material as to adopt the overall economy into the process and then economic and financial incentives as I said these are important the government, the state government, central government they should make a policy for providing the incentives and some economic benefits to the industrial players who adopt this industrial complexing process and even in certain cases this economic support could be considered in the form of financial aid to promote the shared resources over the primary raw material and the energy.

So, let us discuss about the various elements of industrial complexing. So, like if we discuss the different elements, so first an important element that is basically the embedded energy and the material. So embedded energy basically that is the sum of the hidden resources to make the product possible so that is basically the hidden resource that is basically in the form of resource

that is used in the extraction from the raw material primary or secondary manufacturing process which also involves the transportation so reusing the byproduct basically allows the consumption of this embedded energy further.

So, this is an important element that is required for industrial complexing process.

And the second element of this industrial complexing that is the life cycle perspective. So, life cycle perspective means tracking of the raw material from its cradle to grave. So, that is like track the transformation of the resource when it is mined out and till it is exposed or utilized in different unit operations and converted into the product and even after the product is made after its utilization how that product is discarded how it is recycled or disposed into the system so this basically the overall life cycle analysis of the raw material or the resource level that basically very important elements in accomplishing the industrial complexing phenomena, because this allows consideration of entire set of environmental impact at each stages of manufacturing. So for example if we see that is the natural resources and here the life cycle of the product A, if we see and this is the life cycle of product B and this is if we take the life cycle analysis of the product C so here what we can see the product a that can be used by one industry to another industries for the production of another product so that is like the interrelation of the product to each other in a close life cycle perspective in such a way that the closed loop manufacturing system is established and that results into the circular economy of the process resulting into minimum waste. So, this is if we see the more details of say if we take the life cycle analysis of A that is the material processing then its production and then finally it is used and then it is disposed off so in uses the product life cycle of another product say B that can be used as a raw material for production of product A instead of product B. So, similarly the waste generated from the product B that can be used as a raw material here in the production process for the material C. So, that basically is processed and then it is generated the products which are used and finally whatever the waste that is basically the generated that is being finally disposed off. So, this is the entire life cycle perspectives which are to be carefully analyzed in order to minimize the waste and to inter-use the raw materials or high products from one industry to another industry to be used in a circular closed system in such a way that minimizes the generation of waste and also to generate the maximum product the useful products out of the waste. So, that is the life cycle analysis of the different raw material and resources which are used in a close proximity of the industries to adopt the industrial complexing concept.

And then that is the third element that is the cascading impact so that is the resource basically which is to be used repeatedly into different applications so changes in the grade of the course and cascade basically ends up when the resource is discarded or requires a lot of energy to reuse recycle and to recover its value. So, that basically cascading effects that is like if we see that is the fresh or potable water that is extracted which is used to wash out the rice in the plants after washing whatever the wastewater that is used basically that contains a lot of suspended impurities and that cloudy water again that can be used for irrigation of the crop in the agricultural applications. So, that basically one fresh water that has been used in one operation and then again it is used in the irrigation purpose so that is like the cascading effect of using one resource repeatedly many times from one industrial operations to another industrial operation and this has to be carried out till the waste requires a lot of energy to reinstate its value or reutilization of the

waste into valuable products so then finally that is discarded into the environment because then it becomes very costlier for recycling and reuse of the waste. So, finally that has to be disposed off.

And this is loop closing and its impact. So, that is basically the return of material to a form similar to its previous ones, so that is basically the material has to be used in the one industry to another industry from one process to another process and then finally it has to be returned to its previous form so as to adopt a closed loop cycles and the impact of this closed loop cycle if we see that basically reduces the use of the fresh raw materials or the resource which ultimately reduces the deposition of waste into the environment. So, here if we see the waste produced from manufacturing process and this is the fresh raw material and the waste produced from another industry that together has to be used and that generates different products and then using distribution logistics sales and details and consumption and utilization of these products and again converting the waste into reusable form of resource. So, that basically constitute a closing loop cycle which is very very essential for sustainable resource management.

So then let us talk about the various issues of industrial complexing so that is the first one that is the tracking of material means the auditing the types and how much amount of material water energy that flows into the system or into the industrial operations and then we see the forms which are clearly defined by their rate of inputs and outputs and finally we see that is the amount of feed stocks and the byproducts that may be sourced from and circulated within the industries or the operations which exist within the closed loop cycles and finally the synergistic industry that would be consolidating the process within the industry, so as to adopt the closed loop circles for reutilization and reuse of these materials.

So, another issues related with the industrial complexing that is limitations in the material profile basically that various software are used for modeling and determining the flux of the process which may over estimates the material flow and energy flow, so that is one of the limitations associated with this process and then recognition of time consuming process like the business deadline and the most of the industrial byproducts that are basically also not intentionally created or reused and their adaptability that make a challenging issue and then the matching output to feed stock requirements should include the analysis of grades of various entities presented to the material. So, because of these limitations that basically sometimes becomes the hurdles in attaining the industrial complexing phenomena.

And then the stakeholder process, so in the stakeholder process if we see that the industrial complexing basically that should be tailored to a certain community or depending upon the cooperative players basically, they are involved in the process. so here different players like if we see the industry players then government and then the organizations regulatory agencies so they basically all together they have integration to each other so as to get the successful industrial complexing. So this the different stakeholder which are required like industry player, government and the environmental regulatory agencies. So, their rules are very-very important for attaining the successful industrial complexing.

So, these are the references and thank you.